MANUAL UPDATES

The enclosed is updated material for the System Maintenance Manual, Number 9023.400, for the CS-8952 Field Deployable X-ray System.

These pages contain information on the new shipping fixtures, update the generator calibration procedure using non-invasive meters, and contain additional drawings on the table.

INSTRUCTIONS:

Each manual consists of two 3-1/2" wide gray 3-ring binders, labeled "Volume I" and "Volume II".

1. Each system was shipped with two sets of manuals. Locate both sets. The shrink-wrapped package contains material for updating both sets of manuals.

2. The enclosed pages replace three chapters in the manual:

   in Volume 1, Chapter 2 - Installation
   in Volume 1, Chapter 3 - Calibration
   in Volume 2, Chapter 7 - Table.

The chapters are separated by colored pages. Each page is labeled with its chapter name on the bottom of the page.

3. Replace all of Chapter 2 with the new pages.

4. In Chapter 3, Calibration, locate the 22 x 33" multi-fold "Test Pattern", page 5-25. This will become FIGURE 5-3, Page 5-7.

Position the enclosed pressure-sensitive label over the figure and page number on the drawing to correct the designation. Insert the corrected "Test Pattern" at page 5-7 in the new chapter.

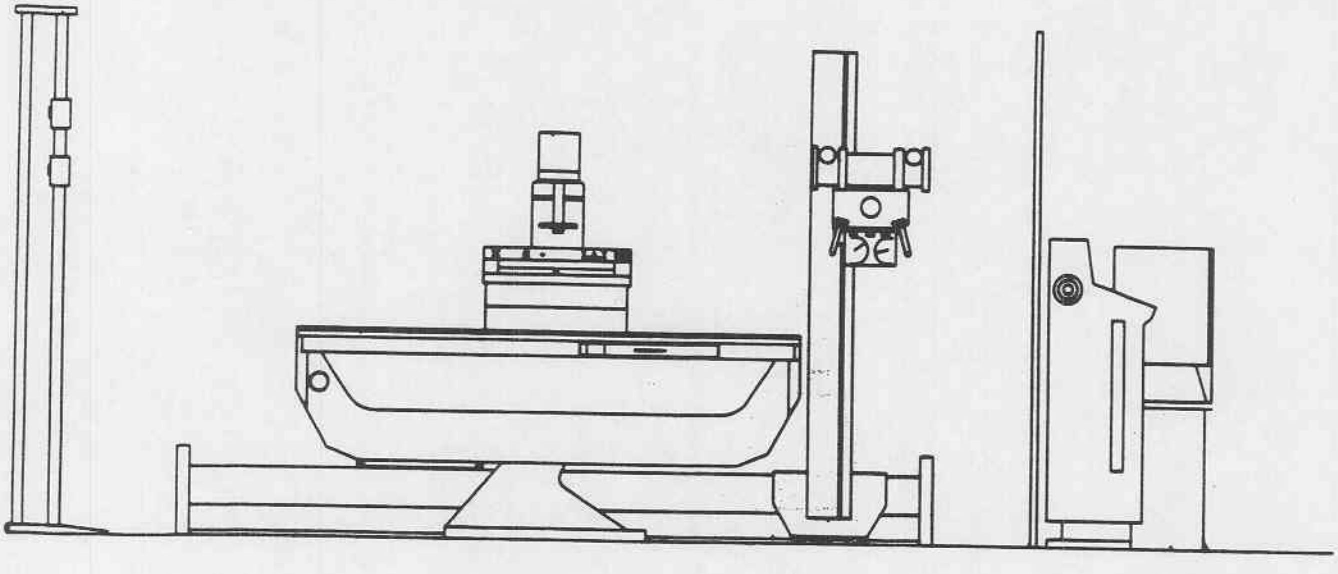
Replace Chapter 3 with the new pages.

5. Replace all of Chapter 7 with the new pages.

CS-8952 FIELD DEPLOYABLE
X-RAY SYSTEM

SYSTEM MAINTENANCE MANUAL 9023.400

VOLUME II



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ORGANIZATION OF CHAPTERS

VOLUME I

CHAPTER 1 - GENERAL

CHAPTER 2 - INSTALLATION

CHAPTER 3 - CALIBRATION

CHAPTER 4 - TROUBLESHOOTING

CHAPTER 5 - OPERATION

CHAPTER 6 - MXT-350 GENERATOR

VOLUME II

CHAPTER 7 - MXT-90/15 TABLE

CHAPTER 8 - TUBESTAND

CHAPTER 9 - AUXILIARY BOX

CHAPTER 10 - SPOT FILM DEVICE

CHAPTER 11 - UNDER-TABLE COLLIMATOR

CHAPTER 12 - OVER-TABLE COLLIMATOR

CHAPTER 13 - AUTOMATIC EXPOSURE CONTROL

CHAPTER 14 - IMAGE INTENSIFIER

CHAPTER 15 - X-RAY TUBES

CHAPTER 16 - MISCELLANEOUS

TABLE OF CONTENTS

VOLUME I

SECTION PAGE

CHAPTER 1 - GENERAL

1 INTRODUCTION . . . 1-1
1.1 HOW TO USE THIS MANUAL . . . 1-1
1.2 SCOPE . . . 1-1
1.3 SAFETY RECOMMENDATIONS AND BASIC SAFETY RULES . . . 1-2
1.4 MAXIMUM PERMISSIBLE DOSE . . . 1-3
1.5 CDRH COMPLIANCE . . . 1-3

2 SPECIFICATIONS . . . 2-1
2.1 GENERATOR SPECIFICATIONS . . . 2-1
2.2 TABLE SPECIFICATIONS . . . 2-3
2.3 TUBESTAND SPECIFICATIONS . . . 2-4

3 STORAGE . . . 3-1
3.1 GENERAL . . . 3-1
3.2 LUBRICATION SPECIFICATIONS . . . 3-1
3.3 STORAGE INFORMATION OF SPOT FILM DEVICE . . . 3-2
3.4 STORAGE INFORMATION OF THE IMAGE INTENSIFIER SYSTEM . . . 3-2

CHAPTER 2 - INSTALLATION

1 GENERAL . . . 1-1
1.1 SCOPE . . . 1-1
1.2 TOOLS REQUIRED . . . 1-1
1.3 EQUIPMENT REQUIRED . . . 1-1
1.4 TRANSPORTATION . . . 1-1
1.5 UNPACKING . . . 1-5
1.6 DIRECTIONAL ASSIGNMENT NAMING CONVENTION USED . . . 1-6
1.7 TRANSPORT DEVICE . . . 1-7
1.8 MOVING THE TUBESTAND . . . 1-10
1.8.1 MOUNTING THE TUBESTAND . . . 1-10
1.9 MOVING THE TABLE . . . 1-16
1.9.1 TABLE MOUNTING . . . 1-18
1.9.2 TABLE TOP REMOVAL AND SETUP . . . 1-23
1.9.3 FRONT COUNTERWEIGHT INSTALLATION . . . 1-25
1.9.4 REAR COUNTERWEIGHT INSTALLATION . . . 1-25
1.10 RADIATION SHIELD . . . 1-29

TABLE OF CONTENTS

VOLUME I

SECTION PAGE

CHAPTER 2 - INSTALLATION (continued)

1.11 MOVING GENERATOR COMPONENTS 1-31
1.11.1 MOUNTING GENERATOR 1-34
1.12 UNPACKING AND MOUNTING THE UNDER-TABLE COLLIMATOR AND X-RAY TUBE 1-38
1.13 UNPACKING AND MOUNTING THE SPOT FILM DEVICE AND IMAGE INTENSIFIER 1-38
1.14 ELECTRICAL CONNECTIONS 1-43
1.15 OVER-TABLE COLLIMATOR AND X-RAY TUBE INSTALLATION 1-43
1.15.1 OVER-TABLE X-RAY TUBE INSTALLATION 1-43
1.15.2 OVER-TABLE COLLIMATOR INSTALLATION 1-47
1.16 LEVELING THE TABLE AND PLUMBING THE TOWER 1-48
1.17 TABLE OPERATIONAL CHECK 1-49

2 TRANSPORT DEVICE PARTS LIST 2-1

CHAPTER 3 - CALIBRATION

1 GENERAL 1-1
1.1 SCOPE 1-1
1.2 TOOLS AND MATERIAL REQUIRED 1-1
1.3 TEST EQUIPMENT REQUIRED 1-2
1.4 INSTALLATION OF TEST EQUIPMENT WITH A DYNALYZER 1-3
1.4.1 INSTALLATION OF TEST EQUIPMENT WITH NONINVASIVE METERS 1-3
1.5 WARM UP PROCEDURE 1-4

2 MXR-350 GENERATOR 2-1
2.1 INTRODUCTION 2-1
2.2 50/60 HZ CONVERSION 2-4
2.3 LINE COMPENSATION 2-9
2.4 KVP COMPENSATION 2-11
2.4.1 DETERMINATION OF LINE DROP 2-11
2.4.2 KVP COMPENSATION USING DYNALYZER 2-15
2.4.3 KVP COMPENSATION WITH NONINVASIVE KVP METER 2-20
2.5 ROTOR ADJUSTMENT (BOOST TIME) 2-25
2.6 TUBE OVERLOAD ADJUSTMENTS (TOLA) 2-31
2.7 RADIOGRAPHIC TIMER (50HZ AND 60HZ) VERIFICATION 2-31
2.7.1 60 HZ RADIOGRAPHIC TIMER CALIBRATION 2-33

TABLE OF CONTENTS

VOLUME I

SECTION PAGE

CHAPTER 3 - CALIBRATION (continued)

2.7.2 50 HZ RADIOGRAPHIC TIMER CALIBRATION 2-38
2.8 BACK-UP TIMER (50 HZ AND 60 HZ) VERIFICATION 2-39
2.8.1 60 HZ BACK UP TIMER CALIBRATION 2-40
2.8.2 50 HZ BACK UP TIMER CALIBRATION 2-45
2.9 MA FILAMENT (OVER-TABLE X-RAY TUBE) USING DYNALYZER 2-46
2.9.1 MA FILAMENT USING NONINVASIVE METERS (OVER-TABLE X-RAY TUBE) 2-50
2.10 SPACE CHARGE COMPENSATION 2-53
2.11 UNDER-TABLE TUBE CALIBRATION 2-56
2.12 MA FILAMENT (UNDER-TABLE X-RAY TUBE) 2-56
2.13 SPACE CHARGE COMPENSATION (UNDER-TABLE X-RAY TUBE) 2-57
2.14 SPOT FILM PREHEAT 2-57
2.15 FLUOROSCOPIC KVP 2-58
2.16 FLUOROSCOPIC MA USING DYNALYZER 2-59
2.16.1 FLUOROSCOPIC MA USING NONINVASIVE METERS 2-60
2.17 EXPOSURE MAS 2-65
2.18 END OF EXPOSURE SIGNAL 2-65

3 SPOT FILM DEVICE CALIBRATION 3-1

4 UNDER-TABLE COLLIMATOR CALIBRATION 4-1
4.1 SCOPE 4-1
4.2 GENERAL DESCRIPTION 4-1
4.3 SERVICE ADJUSTMENTS, CONTROLS & INDICATORS 4-3
4.3.2 TEST POINTS AND FUNCTION 4-3
4.3.3 ANALOG VOLTAGE CHANNEL SWITCH 4-5
4.3.4 CALIBRATION/MODE SWITCH AND ALPHANUMERIC DISPLAY 4-7
4.3.5 SID RATIO AND CALIBRATION SWITCH 4-12
4.3.6 RESET SWITCH 4-13
4.3.7 WATCHDOG TIMER SHUNT 4-13
4.3.8 +5 VOLT A/D REFERENCE ADJUSTMENT 4-13
4.3.9 SPOT-FILM REFERENCE VOLTAGE ADJUSTMENT 4-13
4.3.10 COLLIMATOR POTENTIOMETER REFERENCE (VCP) ADJUSTMENT 4-14
4.3.11 CONTINUOUS SID MONITOR ADJUSTMENTS 4-14
4.3.12 COLLIMATOR SHUTTER CALIBRATION ADJUSTMENTS 4-14

TABLE OF CONTENTS

VOLUME I

SECTION PAGE

CHAPTER 3 - CALIBRATION (continued)

4.3.12.1 SHUTTER DRIVE INDICATORS 4-15
4.3.13 +5.0 VOLT A/D REFERENCE CALIBRATION 4-15
4.3.14 SPOT-FILM REFERENCE VOLTAGE CALIBRATION 4-15
4.3.15 COLLIMATOR HEAD REFERENCE VOLTAGE CALIBRATION . . 4-15
4.3.16 CONTINUOUS SID ADJUSTMENT 4-16
4.3.17 COLLIMATOR SHUTTER CALIBRATION 4-17
4.3.17.1 DESCRIPTION 4-17
4.3.17.2 COLLIMATOR SHUTTER ACCESS 4-17
4.3.17.3 SHUTTER OFFSET ADJUSTMENT 4-17
4.3.17.4 SHUTTER GAIN ADJUSTMENT 4-18
4.3.17.5 RE-ASSEMBLY 4-19
4.4 OPERATIONAL CHECKOUT PROCEDURE 4-20
4.4.1 DESCRIPTION 4-20
4.4.2 COLLIMATOR CENTERING ALIGNMENT 4-20
4.4.3 FLUOROSCOPIC IMAGE SIZE (I.I.) ADJUSTMENT 4-23
4.4.4 1-ON-1 (FULL) RADIOGRAPHIC FILM ADJUSTMENT 4-23
4.4.5 2-ON-1 LONGITUDINAL RADIOGRAPHIC FILM ADJUST 4-24
4.4.6 2-ON-1 TRANSVERSE RADIOGRAPHIC FILM ADJUST 4-24
4.4.7 3-ON-1 RADIOGRAPHIC FILM ADJUSTMENT 4-25
4.4.8 4-ON-1 RADIOGRAPHIC FILM ADJUSTMENT 4-25
4.4.9 6-ON-1 RADIOGRAPHIC FILM ADJUSTMENT 4-26
4.4.10 9-ON-1 RADIOGRAPHIC FILM ADJUSTMENT 4-26
4.4.11 SID TRACKING VERIFICATION 4-26

5 **OVER-TABLE COLLIMATOR CALIBRATION** 5-1
5.1 OPERATIONAL CHECKOUT PROCEDURES - MODEL LINEAR II . 5-1
5.1.1 PRELIMINARY SETUP 5-1
5.1.2 COLLIMATOR TILT SWITCH CHECKOUT 5-3
5.1.3 TABLE TILT SWITCH CHECKOUT 5-3
5.1.4 LOGIC AND COLLIMATOR OPERATION CHECKOUT 5-5
5.1.5 TABLE RECEPTOR SID SIGNAL CHECKOUT 5-6
5.1.6 EXTERNAL IR SIGNALS CHECKOUT 5-7
5.1.7 INPUT SIGNAL VERIFICATION CHART 5-9
5.1.8 FINAL TEST SWITCH SETTINGS 5-9
5.2 ADJUSTMENT PROCEDURES 5-11
5.2.1 LIGHT FIELD/X-RAY CONGRUENCE TEST 5-13
5.2.2 40" SID ADJUSTMENT 5-15
5.2.3 COLLIMATOR FEEDBACK LINEARITY TEST 5-16
5.2.4 CASSETTE TRAY ADJUSTMENT 5-18

TABLE OF CONTENTS

VOLUME I

SECTION PAGE

CHAPTER 3 - CALIBRATION (continued)

5.3 ALIGNMENT PROCEDURES 5-19
5.3.1 FIELD PROJECTION LAMP AND MIRROR ADJUSTMENT 5-19
5.3.2 CROSS-HAIR WINDOW ADJUSTMENT 5-22
5.3.3 BUCKY CENTERING LIGHT-LINE ADJUSTMENT 5-23
5.3.4 COLLIMATOR POTENTIOMETER VOLTAGE ADJUSTMENT (VCPL, VCPC) 5-24
5.4 TEST PATTERN 5-25

6 AUTOMATIC EXPOSURE CONTROL CALIBRATION 6-1
6.1 FIELD CALIBRATION INSTRUCTIONS 6-1
6.2 PRELIMINARY STEPS 6-1
6.3 KVP LEVEL ADJUSTMENT 6-5
6.4 CHAMBER GAIN (MAIN DENSITY) ADJUSTMENT. 6-6
6.5 FIELD MATCHING 6-8
6.6 KVP COMPENSATION 6-9
6.7 CONCLUSION OF FIELD CALIBRATION 6-11

7 IMAGE INTENSIFIER CALIBRATION 7-1
7.1 IMAGE TUBE FOCUS 7-1

CHAPTER 4 - TROUBLESHOOTING

1 SUB-SYSTEM TROUBLESHOOTING 1-1
1.1 SCOPE 1-1
1.2 GENERATOR FAULT CONDITIONS 1-1
1.3 X-RAY TABLE FAULT CONDITIONS 1-3
1.4. TUBESTAND FAULT CONDITIONS 1-5
1.5 SPOT FILM DEVICE FAULT CONDITIONS 1-6
1.6 COLLIMATOR FAULT CONDITIONS 1-7
1.7 AUTOMATIC EXPOSURE CONTROL FAULT CONDITIONS 1-8
1.8 IMAGE INTENSIFIER FAULT CONDITIONS 1-9

2 SYSTEM WIRE LISTS 2-1
2.1 GLOSSARY OF ABBREVIATIONS 2-1
2.2 SYSTEM LEVEL WIRE LIST 2-4
2.3 SFD CABLES 2-33
2.4 ION CHAMBER CABLE 2-37
2.5 SID SW CABLE 2-38
2.6 COLLIMATOR LOGIC CABLE 2-39

TABLE OF CONTENTS

VOLUME I

SECTION PAGE

CHAPTER 5 - OPERATION

1 INTRODUCTION 1-1
1.1 GENERAL 1-1
1.2 SAFETY RECOMMENDATIONS AND BASIC SAFETY RULES 1-1
1.3 MAXIMUM PERMISSIBLE DOSE 1-2
1.4 CDRH COMPLIANCE 1-2

2 CONTROLS AND INDICATORS 2-1
2.1 INTRODUCTION 2-1
2.2 MXR-350 GENERATOR MAIN PANEL CONTROLS 2-1
2.2.1 FLUOROSCOPIC CONTROLS 2-1
2.2.2 RADIOGRAPHIC (X-RAY) CONTROLS 2-1
2.2.3 METERS 2-6
2.3 SPOT FILM DEVICE 2-7
2.4 TABLE CONTROLS 2-15
2.5 TUBESTAND AND RADIOGRAPHIC COLLIMATOR 2-17
2.6 IMAGING SYSTEM 2-20
2.7 SYSTEM ACCESSORIES 2-21

3 DAILY PRE-OPERATIONAL SYSTEM CHECK 3-1
3.1 INTRODUCTION 3-1
3.2 DAILY PRE-OPERATIONAL SYSTEM CHECK 3-1

4 OPERATING PROCEDURES 4-1
4.1 INTRODUCTION 4-1
4.2 POWER APPLICATION 4-1
4.3 RADIOGRAPHIC PROCEDURE 4-1
4.4 FLUOROSCOPIC PROCEDURE 4-2
4.5 FLUOROSCOPY WITH SPOT FILM PROCEDURE 4-4

5 BIOLOGICAL EFFECTS OF RADIATION 5-1
5.1 GENERAL 5-1

6 RADIOGRAPHIC TECHNIQUES FOR THE AVERAGE LABORATORY . . 6-1
6.1 INTRODUCTION 6-1
6.2 BASIC TECHNIQUES 6-1
6.3 USING THE TECHNIQUE CHART 6-1
6.4 SUPPLEMENTAL INFORMATION 6-3

7 OPERATOR MAINTENANCE 7-1
7.1 INTRODUCTION 7-1
7.2 SYSTEM INSPECTION 7-1

TABLE OF CONTENTS

VOLUME I

SECTION PAGE

CHAPTER 5 - OPERATION (continued)

8 SYSTEM CLEANING INSTRUCTIONS 8-1
8.1 GENERAL 8-1
8.2 IMAGE INTENSIFIER 8-1
8.3 TUBESTAND 8-1

9 STORAGE INFORMATION 9-1
9.1 GENERAL 9-1
9.2 STORAGE INFORMATION OF SPOT FILM DEVICE 9-1
9.3 STORAGE INFORMATION OF IMAGE INTENSIFIER SYSTEM 9-2

CHAPTER 6 MXT-350 GENERATOR

1 GENERATOR COMPONENTS 1-1
1.1 SCOPE 1-1
1.2 DESCRIPTION 1-1
1.2.1 MAIN CONTROL 1-1
1.2.2 PROTECTIVE CIRCUITS 1-4
1.2.3 HIGH VOLTAGE TRANSFORMER 1-4
1.3 SPECIFICATIONS 1-5
1.4 ADJUSTMENTS AND CALIBRATION 1-6

2 CIRCUIT DESCRIPTION 2-1
2.1 POWER CIRCUIT, CIRCUIT FUNCTION DESCRIPTION, CFD 1.0 2-1
2.2 HIGH VOLTAGE GENERATOR CIRCUIT, CFD 1.1 2-4
2.3 HIGH VOLTAGE GENERATOR INTERCONNECTIONS 2-6
2.4 CIRCUIT BREAKERS, CFD 1.2 2-7
2.5 LIGHT CIRCUIT, CFD 1.3 2-9
2.6 EXPOSURE CIRCUIT, CFD 2.0 2-11
2.7 MA OVERLOAD CIRCUIT, CFD 2.1 2-15
2.8 MA, TIME, & KVP OVERLOAD (TOLA) CIRCUIT, CFD 2.2 2-18
2.9 EXPOSURE END SIGNAL, CFD 2.4 2-21
2.10 EXPOSURE AND AUTOTIMER SAFETY CIRCUIT, CFD 2.6 2-23
2.11 FILAMENT CIRCUIT, CFD 3.0 2-25
2.12 SPACE CHARGE COMPENSATION, CFD 3.1 2-28
2.13 FILAMENT SELECTION, CFD 3.2 2-30
2.14 FILAMENT BOOST CIRCUIT, CFD 3.3 2-33
2.15 FLUORO RATE CONTROL, CFD 3.4 2-35
2.16 KVP METER CIRCUIT, CFD 4.0 2-38
2.16.1 RADIOGRAPHIC KVP 2-38

TABLE OF CONTENTS

VOLUME I

SECTION PAGE

CHAPTER 6 MXT-350 GENERATOR (continued)

2.16.2 FLUOROSCOPIC KVP 2-39
2.17 MA METER & SHUNT CIRCUIT, CFD 5.0 2-41
2.18 MAS METER CIRCUIT, CFD 5.1 2-45
2.19 SINGLE PHASE IMPULSE TIMER CIRCUIT, CFD 6.0 2-47
2.20 TIME SELECTOR SWITCH 2-51
2.21 BACK-UP TIMER, CFD 6.2 2-52
2.22 SINGLE PHASE SCR CONTACTOR CIRCUIT, CFD 6.3 2-55
2.23 ROTOR CONTROL CIRCUIT, CFD 7.0 2-57
2.24 SPOT FILM CHANGEOVER CIRCUIT, CFD 8.1 2-61
2.25 AUTOTIMER DENSITY SELECTION 2-65
2.26 AUTOTIMER & BACK-UP TIMER INTERLOCK 2-65
2.27 AUTOTIMER RESET AND FIELD SELECTOR, CFD 9.0 2-66
2.28 AUXILIARY RELAY CIRCUIT, CFD 9.3 2-68
2.29 AUTOTIMER TECHNIQUE SELECTOR, CFD 9.4 2-70

3 MAINTENANCE 3-1
3.1 INTRODUCTION 3-1
3.2 PREVENTIVE (PERIODIC) MAINTENANCE 3-1
3.2.1 LINE SET ADJUSTMENTS 3-1
3.2.2 NINETY (90) DAY INSPECTION 3-4
3.2.3 TWELVE (12) MONTH INSPECTION 3-5
3.2.4 OPERATIONAL TESTS 3-5
3.3 CORRECTIVE MAINTENANCE 3-6
3.3.1 GENERAL 3-6
3.3.2 HAND TOOLS REQUIRED 3-6
3.3.3 TEST EQUIPMENT 3-6
3.3.4 PARTS REPLACEMENT 3-7

4 MX-350 GENERATOR SIGNALS DESCRIPTION 4-1

5 PARTS LIST 5-1

TABLE OF CONTENTS

VOLUME II

SECTION PAGE

CHAPTER 7 - MXT-90/15 TABLE

1 GENERAL 1-1
1.1 SCOPE 1-1
1.2 TABLE DESCRIPTION 1-1
1.2.1 TABLE TOP 1-1
1.2.2 CARRIAGES AND TOWER 1-3
1.2.3 TABLE BODY 1-3
1.3 SPECIFICATIONS 1-3
1.4 ACCESSORIES 1-4
1.5 HAND TOOLS REQUIRED 1-5
1.6 TABLE OPERATION 1-5
1.7 ACCESSORY ATTACHMENT AND REMOVAL 1-5

2 CIRCUIT DESCRIPTION 2-1
2.1 INTRODUCTION 2-1
2.2 TABLE CIRCUIT DESCRIPTION 2-1
2.3 TABLE TOP DRIVE CONTROL 2-1
2.4 TABLE TILT CONTROL 2-3
2.5 MAGNETIC LOCK AND POWER ASSIST CIRCUITS 2-5
2.6 POWER DISTRIBUTION 2-5

3 MAINTENANCE 3-1
3.1 INTRODUCTION 3-1
3.2 GENERAL INSPECTION 3-1
3.3 COUNTERWEIGHT CABLE INSPECTION 3-2
3.4 OPERATIONAL CHECK 3-7
3.5 LOCK ADJUSTMENTS 3-9
3.5.1 TRANSVERSE AND COMPRESSION LOCK ADJUSTMENT 3-9
3.5.2 LONGITUDINAL AND GRID LOCK ADJUSTMENT 3-9
3.6 TILT DRIVE CHAIN TENSION ADJUSTMENT 3-10
3.7 CLEANING 3-10
3.8 LUBRICATION 3-10
3.9 CORRECTIVE MAINTENANCE 3-11
3.9.1 TABLE TOP REMOVAL AND REPLACEMENT 3-11

TABLE OF CONTENTS

VOLUME II

SECTION PAGE

CHAPTER 7 - MXT-90/15 TABLE (continued)

3.9.2 CABLE REPLACEMENT 3-13
3.9.2.1 UPPER VERTICAL CARRIAGE CABLE REPLACEMENT 3-13
3.9.2.2 FRONT COUNTERWEIGHT CABLE REPLACEMENT 3-13
3.9.2.3 REAR COUNTERWEIGHT CABLE REPLACEMENT 3-14
3.9.2.4 GRID CABINET COUNTERWEIGHT CABLE REPLACEMENT 3-14
3.9.3 VERTICAL (COMPRESSION) LOCK 3-15
3.9.4 TRANSVERSE (FRONT-BACK) LOCK 3-15
3.9.5 LONGITUDINAL (HEAD-FOOT) AND GRID LOCKS 3-17
3.9.6 TILT DRIVE CHAIN REPLACEMENT 3-18

4 **WIRING DIAGRAM AND PARTS LISTS** 4-1

CHAPTER 8 - TUBESTAND

1 **GENERAL** 1-1
1.1 SCOPE 1-1
1.2 DESCRIPTION: 1-1
1.3 TUBESTAND SPECIFICATIONS 1-4

2 **CIRCUIT DESCRIPTION** 2-1
2.1 CIRCUIT DESCRIPTION 2-1
2.2 TUBESTAND CIRCUIT OPERATION 2-1
2.3 LOCK CONTROL CIRCUIT 2-1
2.4 FAN CIRCUIT 2-1
2.5 SID SWITCHES 2-2
2.6 COLLIMATOR CIRCUIT DESCRIPTION 2-4

3 **MAINTENANCE** 3-1
3.1 PREVENTIVE MAINTENANCE 3-1
3.1.1 ELECTRICAL LOCK FAILURE 3-2
3.1.2 STEEL CABLE REPLACEMENT 3-2
3.2 COLLIMATOR 3-2

4 **PARTS LISTS** 4-1

TABLE OF CONTENTS

VOLUME II

SECTION PAGE

CHAPTER 9 - AUXILIARY BOX

1 GENERAL 1-1
1.1 SCOPE 1-1
1.2 HIGH VOLTAGE CABLES 1-1
1.3 AUXILIARY BOX SIGNAL DESCRIPTION 1-3

2 WIRING DIAGRAM AND PARTS LISTS 2-1

CHAPTER 10 - SPOT FILM DEVICE

1.0 INTRODUCTION 1-1
1.1 FEATURES 1-2
1.1.1 SIMPLICITY 1-2
1.1.2 STANDARD FEATURES 1-2
1.1.3 ADVANCED FEATURES 1-2
1.2 SPECIFICATIONS 1-3

2.0 INSTALLATION 2-1
2.1 UNPACKING 2-2
2.2 STORAGE 2-2
2.3 EQUIPMENT SUPPLIED 2-3
2.4 MOUNTING ACCESSORY DEVICES 2-3
2.5 INTERCONNECTING WIRING 2-3
2.6 X-RAY GENERATOR WIRING 2-4

3.0 OPERATIONAL CHECKOUT PROCEDURE 3-1
3.1 OPERATIONAL CHECKLIST 3-2
3.2 POWER ASSIST CHECKOUT 3-3

4.0 CALIBRATION 4-1

TABLE OF CONTENTS

VOLUME II

SECTION PAGE

CHAPTER 10 - SPOT FILM DEVICE (continued)

5.0 OPERATION 5-1
5.1 RADIATION PROTECTION 5-2
5.2 MAXIMUM PERMISSIBLE DOSE 5-3
5.3 MANUFACTURER'S RESPONSIBILITY 5-3
5.4 MONITORING OF PERSONNEL 5-5
5.5 PUSHBUTTON SWITCHES AND LED DISPLAY 5-5
5.6 POWER ASSIST HANDLE 5-9
5.7 MANUAL POSITIONING 5-10
5.8 OPERATING PROCEDURES 5-10
5.9 OPERATING DETAILS 5-12
5.10 OPERATOR MAINTENANCE 5-13
5.11 OPERATIONAL TESTS 5-14
5.12 CLEANING 5-14

6.0 COMPLIANCE VERIFICATION 6-1
6.1 VERIFICATION TEST TO BE PERFORMED 6-3
XR8-2.16 MINIMUM FIELD SIZE 6-4
XR8-2.20 X-RAY FIELD LIMITATION AND ALIGNMENT 6-6
XR8-2.24 FLUOROSCOPIC X-RAY FIELD LIMITATION 6-9
XR8-2.29 ALIGNMENT OF X-RAY FIELD EDGES TO SELECTED PORTIONS OF THE IMAGE RECEPTOR 6-15
XR8-2.30 ALIGNMENT OF CENTER OF X-RAY FIELD TO CENTER OF SELECTED PORTION OF IMAGE RECEPTOR 6-19

7.0 MAINTENANCE/REPAIR 7-1
7.1 CORRECTIVE MAINTENANCE 7-2
7.2 REAR COVER REMOVAL AND REPLACEMENT 7-2
7.3 FRONT COVER REMOVAL 7-3
7.4 POSITION SENSING 7-4
7.5 ADJUSTMENT OF CHASSIS SENSORS 7-4
7.6 ESTABLISHING HOME POSITION OF CASSETTE CARRIAGE 7-7
7.7 ADJUSTMENT OF HANDLE SENSORS 7-8
7.8 INTERFACE CIRCUIT BOARD REMOVAL AND REPLACEMENT . . 7-9
7.9 CPU CIRCUIT BOARD REMOVAL AND REPLACEMENT 7-9
7.10 FRONT PANEL CIRCUIT BOARD REMOVAL AND REPLACEMENT 7-10
7.11 STEPPER MOTOR REPLACEMENT 7-11
7.12 CLUTCH/BRAKE ASSEMBLY REPLACEMENT 7-12

TABLE OF CONTENTS

VOLUME II

SECTION PAGE

CHAPTER 10 - SPOT FILM DEVICE (continued)

7.13 BELT REPLACEMENT 7-13
7.13.1 FRONT-TO-BACK BELT REPLACEMENT 7-14
7.13.2 SIDE-TO-SIDE REPLACEMENT 7-15

8.0 THEORY OF OPERATION 8-1
8.1 MECHANICAL OPERATION 8-2
8.2 INTRODUCTION TO ELECTRONIC THEORY 8-2
8.3 BLOCK DIAGRAM DISCUSSION 8-3
8.4 CIRCUIT DESCRIPTION 8-3
8.4.1 CPU BOARD (70-08078) 8-5
8.4.2 INTERFACE BOARD (70-08077) 8-7
8.4.3 KEYBOARD/DISPLAY BOARD (70-08079) 8-9
8.4.4 POWER SUPPLY (70-10416) 8-10

9.0 NOT APPLICABLE FOR THIS MANUAL

10.0 SCHEMATICS AND BILLS OF MATERIAL 10-1

CHAPTER 11 - UNDER-TABLE COLLIMATOR

1.0 INTRODUCTION 1-1
1.1 YOU HAVE LEGAL OBLIGATIONS 1-3
1.2 BACKGROUND 1-3
1.3 LINEAR™ SERIES COLLIMATOR FEATURES 1-4
1.4 STANDARD FEATURES 1-5
1.5 SPECIFICATIONS 1-5
1.6 RADIATION AND MECHANICAL/ELECTRICAL WARNING 1-7
1.7 COMPATIBILITY 1-8
1.8 MAINTENANCE 1-8
1.9 COMPLIANCE REQUIREMENTS 1-9

TABLE OF CONTENTS

VOLUME II

SECTION PAGE

CHAPTER 11 - UNDER-TABLE COLLIMATOR (continued)

2.0 INSTALLATION 2-1
2.1 UNPACKING 2-3
2.2 EQUIPMENT SUPPLIED 2-3
2.3 COLLIMATOR MOUNTING AND INTERFACING 2-3
2.4 LOGIC ASSEMBLY INTERFACING 2-9
2.5 SID MONITOR POTENTIOMETER ADJUSTMENT 2-10

3.0 CALIBRATION 3-1
3.1 GENERAL DESCRIPTION 3-3
3.2 SERVICE ADJUSTMENTS, CONTROLS AND INDICATORS 3-4
3.3 +5 VOLT A/D REFERENCE CALIBRATION 3-11
3.4 SPOTFILM REFERENCE VOLTAGE CALIBRATION 3-11
3.5 COLLIMATOR HEAD REFERENCE VOLTAGE CALIBRATION . . 3-11
3.6 CONTINUOUS SID ADJUSTMENT 3-11
3.7 COLLIMATOR SHUTTER CALIBRATION 3-13

4.0 OPERATIONAL CHECKOUT PROCEDURE 4-1
4.1 DESCRIPTION 4-3
4.2 COLLIMATOR CENTERING ALIGNMENT 4-3
4.3 FLUOROSCOPIC IMAGE SIZE (I.I.) ADJUSTMENT 4-3
4.4 1-ON-1 (FULL) FILM ADJUSTMENT 4-4
4.5 2-ON-1 LONGITUDINAL FILM ADJUSTMENT 4-4
4.6 2-ON-1 TRANSVERSE FILM ADJUSTMENT 4-5
4.7 3-ON-1 FILM ADJUSTMENT 4-5
4.8 4-ON-1 FILM ADJUSTMENT 4-5
4.9 6-ON-1 FILM ADJUSTMENT 4-6
4.10 9-ON-1 FILM ADJUSTMENT 4-6
4.11 SID TRACKING VERIFICATION 4-6

TABLE OF CONTENTS

VOLUME II

SECTION PAGE

CHAPTER 11 - UNDER-TABLE COLLIMATOR (continued)

5.0 COMPLIANCE VERIFICATION 5-1
5.1 VERIFICATION TESTS TO BE PERFORMED 5-3
XR8-2.09 BEAM QUALITY 5-4
XR8-2.16 MINIMUM FIELD SIZE 5-9
XR8-2.20 X-RAY FIELD LIMITATION AND ALIGNMENT 5-11
XR8-2.24 FLUOROSCOPIC X-RAY FIELD LIMITATION 5-14
XR8-2.25 FLUORO SOURCE-TO-SKIN DISTANCE 5-22
XR8-2.27 PRIMARY BARRIER - X-RAY LOCKOUT 5-25
XR8-2.29 ALIGNMENT OF X-F EDGES TO IMAGE RECEPTOR 5-25
XR8-2.30 ALIGNMENT OF CENTER OF X-F IMAGE RECEPTOR 5-27
RECORD SHEET 5-31

6.0 NOT APPLICABLE FOR THIS MANUAL

7.0 THEORY OF OPERATION 7-1
7.1 MECHANICAL OPERATION 7-4
7.2 ELECTRONIC OPERATION 7-4

8.0 APPENDIX 8-1
DEFINITIONS 8-2

9.0 SCHEMATICS AND BILLS OF MATERIAL 9-1

CHAPTER 12 - OVER-TABLE COLLIMATOR

1.0 INTRODUCTION 1-1
1.1 YOU HAVE LEGAL OBLIGATIONS 1-3
1.2 BACKGROUND 1-3
1.3 COLLIMATOR FEATURES 1-4
1.4 STANDARD FEATURES 1-4
1.5 ADVANCED FEATURES 1-5
1.6 TECHNICALLY ADVANCED FEATURES 1-5

TABLE OF CONTENTS

VOLUME II

SECTION PAGE

CHAPTER 12 - OVER-TABLE COLLIMATOR (continued)

1.7 SPECIFICATIONS 1-5
1.8 RADIATION AND MECHANICAL/ELECTRICAL WARNING 1-6
1.9 COMPATIBILITY 1-7
1.10 MAINTENANCE 1-7
1.11 COMPLIANCE REQUIREMENTS 1-7

2.0 INSTALLATION 2-1
2.1 UNPACKING 2-3
2.2 EQUIPMENT SUPPLIED 2-3
2.3 COLLIMATOR MOUNTING 2-3
2.4 POWER CHASSIS MOUNTING 2-3
2.5 INTERCONNECT WIRING 2-4

3.0 OPERATIONAL CHECKOUT PROCEDURE 3-1
3.1 COLLIMATOR COVER REMOVAL 3-2
3.2 COLLIMATOR TILT SWITCH CHECKOUT 3-3
3.3 TABLE TILT SWITCH CHECKOUT (TILTING TABLES ONLY) 3-4
3.4 LOGIC AND COLLIMATOR OPERATION CHECKOUT 3-4
3.5 EXTERNAL SID SIGNAL CHECKOUT (HORIZONTAL) 3-5
3.6 TILT TABLE RECEPTOR SID SIGNAL CHECKOUT 3-6
3.7 EXTERNAL IR SIGNALS CHECKOUT 3-6
3.8 EXTERNAL IR SIGNALS CHECKOUT FOR TILTING TABLES 3-7
3.9 STEREO/TOMO BYPASS SIGNAL CHECKOUT 3-7
3.10 INPUT SIGNAL VERIFICATION CHART 3-8
3.11 INPUT FINAL TEST SWITCH SETTINGS 3-8

4.0 ADJUSTMENT PROCEDURE 4-1
4.1 LIGHT FIELD/X-RAY FIELD CONGRUENCE TEST 4-2
4.2 40" SID ADJUSTMENT 4-3
4.3 COLLIMATOR FEEDBACK LINEARITY TEST 4-4
4.4 72" SID ADJUSTMENT 4-5
4.5 CASSETTE TRAY ADJUSTMENT 4-5

TABLE OF CONTENTS

VOLUME II

SECTION PAGE

CHAPTER 12 - OVER-TABLE COLLIMATOR (continued)

5.0 ALIGNMENT PROCEDURES 5-1
5.1 FIELD PROJECTION LAMP AND MIRROR ADJUSTMENT 5-3
5.2 CROSS HAIR WINDOW ADJUSTMENT 5-3
5.3 BUCKY CENTERING LIGHT-LINE ADJUSTMENT 5-3
5.4 COLLIMATOR POTENTIOMETER VOLTAGE ADJUSTMENT 5-4

6.0 COMPLIANCE VERIFICATION 6-1
6.1 VERIFICATION TESTS TO BE PERFORMED 6-3
XR8/2.14 VISUAL DEFINITION OF X-RAY LIGHT FIELD 6-5
XR8/2.15 INTENSITY OF LIGHT FIELD ILLUMINATION 6-9
XR8/2.16 MINIMUM FIELD SIZE 6-10
XR8/2.17 X-RAY FIELD RECEPTOR CENTER ALIGNMENT 6-12
XR8/2.18 INDICATION OF FIELD SIZE 6-12
XR8/2.19 POSITIVE BEAM LIMITATION (PBL) 6-13
XR8/2.20 X-RAY FIELD LIMITATION AND ALIGNMENT 6-14
XR8/2.21 RETURN TO PBL WITH IR CHANGE 6-16
XR8/2.22 KEYLOCK PBL OVERRIDE 6-16
XR8/2.09 DETERMINATION OF HALF VALUE LAYER 6-17

7.0 NOT APPLICABLE FOR THIS MANUAL

8.0 APPENDIX 8-1

9.0 THEORY OF OPERATION 9-1
9.1 MECHANICAL OPERATION 9-3
9.2 ELECTRONIC OPERATION 9-3

10.0 BILLS OF MATERIAL AND SCHEMATICS 10-1

CHAPTER 13 - AUTOMATIC EXPOSURE CONTROL

1.0 INTRODUCTION 1-1

2.0 OPERATING INSTRUCTIONS 2-1
2.1 OPERATING CONDITIONS 2-1
2.2 OPERATOR CONTROLS 2-2

TABLE OF CONTENTS

VOLUME II

SECTION PAGE

CHAPTER 13 - AUTOMATIC EXPOSURE CONTROL (continued)

3.0 SPECIFICATIONS 3-1
3.1 SYSTEM PERFORMANCE 3-1
3.2 ION CHAMBER 3-2
3.3 CONTROLS AND DISPLAYS 3-2
3.4 INTERFACE REQUIREMENTS 3-3
3.5 POWER CONSUMPTION 3-3
3.6 PHYSICAL PARAMETERS 3-3
3.7 SCHEDULED MAINTENANCE 3-4
3.8 REGULATORY COMPLIANCE 3-4

4.0 INSTALLATION INSTRUCTIONS 4-1

5.0 FIELD CALIBRATION INSTRUCTIONS 5-1
5.1 PRELIMINARY STEPS 5-2
5.2 CAUTION 5-2
5.3 KVP LEVEL ADJUSTMENT 5-5
5.4 CHAMBER GAIN (MAIN DENSITY) ADJUSTMENT 5-5
5.5 FIELD MATCHING 5-6
5.6 KVP COMPENSATION 5-7
5.7 CONCLUSION OF FIELD CALIBRATION 5-8

6.0 PRINCIPLES OF OPERATION 6-1
6.1 BASIC SYSTEM BLOCKS 6-1
6.2 DIAGNOSTIC/TROUBLESHOOTING GUIDE 6-3
6.3 FACTORY CALIBRATION INSTRUCTIONS 6-8

7.0 DOCUMENTATION
7.1 SCHEMATIC DIAGRAMS 7-1
7.2 COMPONENT LOCATION DIAGRAMS 7-9
7.3 REPLACEMENT PARTS LIST 7-18

TABLE OF CONTENTS

VOLUME II

SECTION PAGE

CHAPTER 14 - IMAGE INTENSIFIER

1 GENERAL 1-1
1.1 SCOPE 1-1
1.2 DESCRIPTION 1-1
1.3 SPECIFICATIONS 1-3
1.3.1 PHYSICAL DIMENSIONS 1-3
1.3.2 WEIGHT 1-3
1.3.3 ELECTRICAL 1-3
1.3.4 OPTICAL CHARACTERISTICS 1-4
1.3.5 MISCELLANEOUS 1-4
1.4 EQUIPMENT SUPPLIED 1-4
1.4.1 EQUIPMENT REQUIRED BUT NOT SUPPLIED 1-4
1.4.2 TEST EQUIPMENT 1-4

2 THEORY OF OPERATION 2-1
2.1 INTRODUCTION 2-1
2.2 IMAGE INTENSIFICATION TUBE 2-1
2.3 POWER SUPPLY 2-1
2.3.1 LOW VOLTAGE SUPPLY 2-1
2.3.2 DC-TO-AC HIGH VOLTAGE CONVERTER 2-4
2.3.3 STABILIZATION AND CONTROL OF OUTPUT VOLTAGE V5 . . . 2-4
2.3.4 OUTPUT VOLTAGE (V5) MULTIPLIER 2-4
2.3.5 VOLTAGE DIVIDER 2-4

3 MAINTENANCE 3-1
3.1 GENERAL MAINTENANCE 3-1
3.2 STORAGE MAINTENANCE 3-1
3.3 IMAGE TUBE FOCUS 3-2
3.4 REPLACING THE POWER SUPPLY 3-3

4 PARTS LIST 4-1

TABLE OF CONTENTS

VOLUME II

SECTION PAGE

CHAPTER 15 - X-RAY TUBES

1 RAD-13 OVERTABLE ROTATING ANODE X-RAY TUBE 1-1
1.1 PRODUCT DATA 1-1
1.2 60 HZ RADIOGRAPHIC EXPOSURE CHARTS 1-2
1.3 60 HZ FILAMENT EMISSION CHARTS 1-3
1.4 50 HZ RADIOGRAPHIC EXPOSURE CHARTS 1-4

2 RAD-14 UNDERTABLE ROTATING ANODE X-RAY TUBE 2-1
2.1 PRODUCT DATA 2-1
2.2 60 HZ RADIOGRAPHIC EXPOSURE CHARTS 2-2
2.3 60 HZ FILAMENT EMISSION CHARTS 2-3
2.4 50 HZ RADIOGRAPHIC EXPOSURE CHARTS 2-4

CHAPTER 16 - MISCELLANEOUS

1 MOBILE CASSETTE HOLDER 1-1

2 LATERAL CASSETTE/GRID HOLDER 2-1

3 MCT SIZE-SENSING TRAY 3-1

4 RADIATION SHIELD 4-1

LIST OF FIGURES

VOLUME I

FIGURE PAGE

CHAPTER 1 - GENERAL

1-1 CS-8952 X-RAY SYSTEM 1-4
1-2 HARD WALL SHELTER CONFIGURATION 1-5
1-3 A TYPICAL HOSPITAL CONFIGURATION 1-6

CHAPTER 2 - INSTALLATION

1-1 EQUIPMENT LAYOUT, OPERATIONAL MODE 1-2
1-2 EQUIPMENT LAYOUT, OPERATIONAL SYSTEM FREE STANDING 1-3
1-3 CS-8952 SYSTEM INSTALLATION IN AN EXPANDABLE ONE-SIDED TACTICAL SHELTER 1-4
1-4 INTEGRATED CONFIGURATION: TRANSPORT DEVICE 1-8
1-5 CRANE FORKS 1-9
1-6 CTC TUBESTAND, WITH CRANE FORKS IN THE SLOTS 1-12
1-7 VERTICAL CARRIAGE SHIPPING BRACKET 1-13
1-8 LONGITUDINAL CARRIAGE SHIPPING BRACKET 1-14
1-9 TRANSVERSE ARM LOCKING BOLT 1-15
1-10 TRANSPORT DEVICE: SEPARATED CONFIGURATION 1-17
1-11 TABLE SPRING LOADED CHECK 1-19
1-12 INSIDE TABLE VIEW OF HEAD-END, WITH CRANE FORK PINS 1-20
1-13 TABLE LATERAL CARRIAGE SHIPPING BRACKET 1-21
1-14 TABLE FLUORO SHIPPING BRACKET 1-22
1-15 TABLE TOP REMOVAL 1-24
1-16 TABLE FRONT COUNTERWEIGHT INSTALLATION 1-26
1-17 TABLE REAR COUNTERWEIGHT INSTALLATION 1-27
1-18 ISO SHELTER FLOOR INSERT PATTERN 1-28
1-19 RADIATION SHIELD 1-30
1-20 TRANSFORMER AND TRANSPORT DEVICE 1-32
1-21 MAIN CONTROL AND TRANSPORT DEVICE 1-33
1-22 PANEL AND CABLE MOUNTING 1-37
1-23 UNDER-TABLE (FLUOROSCOPIC) COLLIMATOR & X-RAY TUBE MOUNTING 1-39
1-24 MOUNTING OF SPOT FILM DEVICE 1-41
1-25 IMAGING INTENSIFIER SYSTEM PLACEMENT 1-42
1-26 SYSTEM LAYOUT, ISO SHELTER 1-44
1-27 SYSTEM LAYOUT, FREESTANDING 1-45

LIST OF FIGURES

VOLUME I

FIGURE PAGE

CHAPTER 2 - INSTALLATION (continued)

1-28 MOUNTING OVER-TABLE TUBE AND COLLIMATOR 1-46
1-29 ECCENTRIC BEARINGS FOR PLUMBING THE TABLE TOWER 1-50

2-1 TRANSPORT DEVICE ASSEMBLY 2-2

CHAPTER 3 - CALIBRATION

2-1 MXR-350 MAIN CONTROL, PART 1 2-2
2-2 MXR-350 MAIN CONTROL, PART 2 2-3
2-3 OPERATOR PANEL MAIN CONTROL 2-6
2-4 60 HZ TIMER SELECT DECK 2-7
2-5 50 HZ TIMER SELECT DECK 2-8
2-6 POWER CIRCUIT 2-10
2-7 MA KVP-LINE METER SHUNT PCB 2-12
2-8 KVP COMPENSATION PANEL 2-27
2-9 SCOPE READING FOR 2.5.3 2-28
2-10 ROTOR CONTROL PCB 2-30
2-11 TOLA ASSEMBLY PCB 2-32
2-12 SCOPE READING FOR 2.7, STEP 5 2-35
2-13 SCOPE READING FOR RADIOGRAPHIC TIMER, 60 HZ & 50 HZ 2-36
2-14 SINGLE PHASE IMPULSE TIMER 2-37
2-15 BACK UP TIMER 2-41
2-16 SCR IMPULSE TIMER 2-42
2-17 SCOPE READING FOR 2.8.7 (60 HZ), 2.8.8 (50 HZ) 2-43
2-18 SCOPE READING FOR 2.8.9 (60 HZ), 2.8.10 (50 HZ) 2-44
2-19 BOOST WAVEFORMS 2-47
2-20 CONSTANT CURRENT FILAMENT CONTROL ASSEMBLY 2-48
2-21 FLUORO MA CONTROL PCB 2-62
2-22 MAS CURRENT INTEGRATOR PCB 2-63
2-23 EXPOSURE END BUZZER 2-64

4-1 UNDER-TABLE LOGIC PCB 4-4
4-2 COLLIMATOR CENTERING 4-21
4-3 FLUOROSCOPIC SHUTTER ALIGNMENT 4-22

LIST OF FIGURES

VOLUME I

FIGURE PAGE

CHAPTER 3 - CALIBRATION (continued)

5-1 OVER-TABLE COLLIMATOR 5-2
5-2 LEDS AND TEST POINTS LOCATION 5-4
5-3 SWITCHES LOCATION 5-4
5-4 LIGHT FIELD/X-RAY CONGRUENCE TEST 5-13
5-5 LIGHT FIELD ADJUSTMENT 5-21
5-6 TEST PATTERN 5-25

6-1 ADJUSTMENT COMPONENT LOCATIONS 6-3
6-2 PREAMPLIFIER ADJUSTMENT COMPONENT LOCATION 6-4

CHAPTER 4 - TROUBLESHOOTING

NO FIGURES

CHAPTER 5 - OPERATION

1-1 CS-8952 X-RAY SYSTEM 1-3
1-2 HARD WALL SHELTER CONFIGURATION 1-4
1-3 A TYPICAL HOSPITAL CONFIGURATION 1-5
2-1 GENERATOR MAIN CONTROL PANEL 2-2
2-2 SPOT FILM FRONT CONTROL PANEL 2-8
2-3 SPOT FILM DEVICE SELECTED DISPLAY 2-14
2-4 TABLE CONTROL PANEL 2-16
2-5 TUBESTAND AND COLLIMATOR CONTROLS 2-19
2-6 IMAGING SYSTEM 2-20
2-7 FOOT REST 2-26
2-8 SHOULDER REST 2-27
2-9 PATIENT HAND GRIPS 2-28
2-10 COMPRESSION BAND 2-29
2-11 UROLOGICAL KNEE CRUTCHES 2-30
2-12 HEAD HOLDER 2-31
2-13 LATERAL CASSETTE HOLDER 2-32
2-14 PATIENT FOOTSTEP 2-33
2-15 MOBILE GRID/CASSETTE/HOLDER 2-34
2-16 CASSETTE SENSING TRAY 2-35

LIST OF FIGURES

VOLUME I

FIGURE PAGE

CHAPTER 6 - MXT-350 GENERATOR

1-1 RADIOGRAPHIC/FLUOROSCOPIC GENERATOR, MXR-350 1-2
1-2 MAIN CONTROL MXR-350, OPERATOR'S CONTROL PANEL 1-3

2-1 CFD 1.0 2-2
2-2 CFD 1.1 2-5
2-3 CFD 1.2 2-8
2-4 CFD 1.3 2-10
2-5 CFD 2.0 2-12
2-6 EXPOSURE INTERLOCK PCB 2-13
2-7 CFD 2.1 2-16
2-8 CFD 2.2 2-19
2-9 CFD 2.4 2-22
2-10 CFD 2.6 2-24
2-11 CFD 3.0 2-26
2-12 CFD 3.1 2-29
2-13 CFD 3.2 2-31
2-14 CFD 3.3 2-34
2-15 CFD 3.4 2-37
2-16 CFD 4.0 2-40
2-17 CFD 5.0 2-42
2-18 CFD 5.1 2-46
2-19 CFD 6.0 2-49
2-20 CFD 6.2 2-53
2-21 CFD 6.3 2-56
2-22 CFD 7.0 2-58
2-23 CFD 8.1 2-62
2-24 RELAY MATRIX PCB 2-63
2-25 CFD 9.0 2-67
2-26 CFD 9.3 2-69
2-27 CFD 9.4 2-71

3-1 CONSTANT CURRENT MULTIPLEX FILAMENT 3-3

LIST OF FIGURES

VOLUME I

FIGURE PAGE

CHAPTER 6 - MXT-350 GENERATOR (continued)

5-1 MXR-350 WIRING DIAGRAM 5-2
5-2 CONTROL ASM (PART 1) 5785.234.01 5-3
5-3 CONTROL ASM (PART 2) 5785.234.01 5-4
5-4 LAYOUT FOR 5184.234.03
MXR-350 AUX TECHNIQUE PNL ASM 5-12
5-5 SCHEMATIC FOR 5184.234.03
MXR-350 AUX TECHNIQUE PNL ASM 5-14
5-6 LAYOUT FOR 5184.234.0310
MXR-350 ION CHAMBER PKUP & DENSITY 5-15
5-7 SCHEMATIC FOR 5184.234.0310
MXR-350 ION CHAMBER PKUP & DENSITY 5-18
5-8 LAYOUT FOR 5184.234.0320
MXR-350 SPOT FILM CHANGEOVER PCB 5-19
5-9 SCHEMATIC FOR 5184.234.0320
MXR-350 SPOT FILM CHANGEOVER PCB 5-21
5-10 LAYOUT FOR 5184.234.04
MXR-350 MA TECH SELECT SWITCH ASM 5-22
5-11 SCHEMATIC FOR 5184.234.04
MXR-350 MA TECH SELECT SWITCH ASM 5-24
5-12 LAYOUT FOR 5184.234.0410
MXR-350 ION CHAMBER POWER-RESET-FIELD SWITCH 5-25
5-13 SCHEMATIC FOR 5184.234.0410
MXR-350 ION CHAMBER POWER-RESET-FIELD SWITCH 5-27
5-14 LAYOUT FOR 5184.234.0501
MXR-350 FLUORO MA CONTROL BOARD ASM 5-28
5-15 SCHEMATIC FOR 5184.234.0501
FLOURO MA CONTROL BOARD ASM 5-30
5-16 LAYOUT FOR 5184.234.06
MXR-350 TIMER SAFETY SWITCH ASM 5-31
5-17 SCHEMATIC FOR 5184.234.06
MXR-350 TIMER SAFETY SWITCH ASM 5-33
5-18 LAYOUT FOR 5184.234.0601
MXR-350 60 HZ IMPULSE TIMER RSTR ASM 5-34

LIST OF FIGURES

VOLUME I

FIGURE PAGE

CHAPTER 6 - MXT-350 GENERATOR (continued)

5-19 SCHEMATIC FOR 5184.234.0601
MXR-350 60 HZ IMPULSE TIMER RSTR ASM 5-36
5-20 LAYOUT FOR 5184.234.0690
MXR-350 UNIVERSAL TOLA RESISTOR ASM 5-37
5-21 SCHEMATIC FOR 5184.234.0690
MXR-350 UNIVERSAL TOLA RESISTOR ASM 5-39
5-22 LAYOUT FOR 5184.234.0698
MXR-350 BACKUP TIMER RESISTOR ASM 5-40
5-23 SCHEMATIC FOR 5184.234.0698
MXR-350 BACKUP TIMER RESISTOR ASM 5-42
5-24 LAYOUT FOR 5184.234.0699
MXR-350 50 HZ IMPULSE TIMER RESISTOR ASM 5-43
5-25 SCHEMATIC FOR 5184.234.0699
MXR-350 50 HZ IMPULSE TIMER RESISTOR ASM 5-45
5-26 LAYOUT FOR 5184.234.08
MXR-350 PREP/EXP PANEL ASM 5-46
5-27 SCHEMATIC FOR 5184.234.08
MXR-350 PREP/EXP PANEL ASM 5-48
5-28 LAYOUT FOR 5184.234.09
MXR-350 FLUORO KVP METER SHUNT ASM 5-49
5-29 SCHEMATIC FOR 5184.234.09
MXR-350 FLUORO KVP METER SHUNT ASM 5-51
5-30 LAYOUT FOR 5184.234.10
MXR-350 FLUORO EXPOSURE INDICATOR ASM 5-52
5-31 SCHEMATIC FOR 5184.234.10
MXR-350 FLUORO EXPOSURE INDICATOR ASM 5-54
5-32 LAYOUT FOR 5184.234.11
MXR-350 SFD PREP DELAY RELAY ASM 5-55
5-33 SCHEMATIC FOR 5184.234.11
MXR-350 SFD PREP DELAY RELAY ASM 5-57
5-34 LAYOUT FOR 5184.234.12
MXR-350 SINGLE PHASE IMPULSE TIMER ASM 5-58
5-35 SCHEMATIC FOR 5184.234.12
MXR-350 SINGLE PHASE IMPULSE TIMER ASM 5-61
5-36 LAYOUT FOR 5184.234.19
MXR-350 FILAMENT DRIVE TRANSISTOR ASM 5-62

LIST OF FIGURES

VOLUME I

FIGURE PAGE

CHAPTER 6 - MXT-350 GENERATOR (continued)

5-37 SCHEMATIC FOR 5184.234.19
MXR-350 FILAMENT DRIVE TRANSISTOR ASM 5-64
5-38 LAYOUT FOR 5184.234.2901
MXR-350 24 VDC EXP END BUZZ ASM 5-65
5-39 SCHEMATIC FOR 5184.234.2901
MXR-350 24 VDC EXP END BUZZ ASM 5-67
5-40 LAYOUT FOR 5281.234.02
MXR-350 TIMER SWITCH ASM 5-68
5-41 LAYOUT FOR 5284.234.1102
MXR-350 235A 800V IMPULSE TIMER /CONTACTOR 5-70
5-42 LAYOUT FOR 5284.234.15
MXR-350 3P FILAMENT RESISTOR PNL ASM 5-72
5-43 SCHEMATIC FOR 5284.234.15
MXR-350 3P FILAMENT RESISTOR PNL ASM 5-74
5-44 LAYOUT FOR 5285.234.01
MXR-350 3P FILAMENT DRIVE COOLING ASM 5-75
5-45 LAYOUT FOR 5285.234.02
MXR-350 CONSTANT VOLTAGE TRANSFORMER ASM 5-77
5-46 LAYOUT FOR 5285.234.03
MXR-350 RESISTOR PANEL ASM 5-79
5-47 LAYOUT FOR 5286.234.04
MXR-350 AUX PWR SUPPLY 50/60 HZ XFNR ASM 5-81
5-48 LAYOUT FOR 5286.234.05
MXR-350 FIL XFMR SUPPLY ASM 50/60 HZ 5-83
5-49 LAYOUT FOR 5485.234.01
MXR-350 TAP SWITCHES PANEL ASM 5-85
5-50 LAYOUT FOR 5585.234.02
MXR-350 CONTACTOR PANEL ASM 5-87
5-51 LAYOUT FOR 6184.234.0803
MXR-350 MAS METER CURRENT INTEGRATOR ASM 5-90
5-52 SCHEMATIC FOR 6184.234.0803
MXR-350 MAS METER CURRENT INTEGRATOR ASM 5-93
5-53 LAYOUT FOR 6284.234.01
MXR-350 UNIVERSAL TOLA ASM 5-94
5-54 SCHEMATIC FOR 6284.234.01
MXR-350 UNIVERSAL TOLA ASM 5-97

LIST OF FIGURES

VOLUME I

FIGURE PAGE

CHAPTER 6 - MXT-350 GENERATOR (continued)

5-55 LAYOUT FOR 6284.234.02
MXR-350 AUX RELAY PNL ASM 5-98
5-56 SCHEMATIC FOR 6284.234.02
MXR-350 AUX RELAY PNL ASM 5-100
5-57 LAYOUT FOR 6284.234.03
MXR-350 KVP COMPENSATION PNL ASM 5-101
5-58 SCHEMATIC FOR 6284.234.03
MXR-350 KVP COMPENSATION PNL ASM 5-103
5-59 LAYOUT FOR 6284.234.04
MXR-350 EXP INTERLOCK PNL ASM 5-104
5-60 SCHEMATIC FOR 6284.234.04
MXR-350 EXP INTERLOCK PNL ASM 5-107
5-61 LAYOUT FOR 6284.234.0803
MXR-350 BACKUP TIMER PANEL ASM 5-108
5-62 SCHEMATIC FOR 6284.234.0803
MXR-350 BACKUP TIMER PANEL ASM 5-111
5-63 LAYOUT FOR 6284.234.09
MXR-350 ROTOR CONTROL W/PHOTOTRANSISTORS 5-112
5-64 SCHEMATIC FOR 6284.234.09
MXR-350 ROTOR CONTROL W/PHOTOTRANSISTORS 5-116
5-65 LAYOUT FOR 6284.234.1009
MXR-350 CONSTANT CURRENT FILAMENT CONTROL ASM 5-117
5-66 SCHEMATIC FOR 6284.234.1009
MXR-350 CONSTANT CURRENT FILAMENT CONTROL ASM 5-121
5-67 LAYOUT FOR 6284.234.11
MXR-350 SCR CONTACTOR TIMER INTERFACE 5-122
5-68 SCHEMATIC FOR 6284.234.11
MXR-350 SCR CONTACTOR TIMER INTERFACE 5-125
5-69 LAYOUT FOR 6284.234.12
MXR-350 MA-KVP-LINE METER SHUNT ASM 5-126
5-70 SCHEMATIC FOR 6284.234.12
MXR-350 MA-KVP-LINE METER SHUNT ASM 5-128
5-71 LAYOUT FOR 6584.234.01
MXR-350 RELAY MATRIX ASM 5-129

LIST OF FIGURES

VOLUME I

FIGURE PAGE

CHAPTER 6 - MXT-350 GENERATOR (continued)

5-72 SCHEMATIC FOR 6584.234.01 MXR-350 RELAY MATRIX ASM 5-131
5-73 LAYOUT FOR 5184.323.02 75 KVP PLUG IN RECTIFIER ASM 5-132
5-74 SCHEMATIC FOR 5184.323.02 75 KVP PLUG IN RECTIFIER ASM 5-134
5-75 LAYOUT FOR 5484.323.02 PLUG-IN HV DIODE BRIDGE ASM 5-135
5-76 LAYOUT FOR 6360.009 150 KV PLUG-IN RECTIFIER ASM 5-137
5-77 ASSEMBLY DRAWING FOR 5786.323.03 MIL 2-TUBE HV TRANSFORMER TOP ASM 5-139
5-78 LAYOUT FOR 6635.300 TRANSFORMER ASSEMBLY 5-142

VOLUME II

CHAPTER 7 - MXT-90/15 TABLE

1-1 MXT-90/15 TABLE ASSEMBLY 1-2

2-1 TABLE TOP DRIVE CIRCUIT 2-2
2-2 TABLE TILT CONTROL 2-4
2-3 MAGNETIC LOCK CIRCUIT 2-6
2-4 POWER DISTRIBUTION 2-7

3-1 SPOT FILM DEVICE TOWER ASSEMBLY 3-3
3-2 FRONT COUNTERWEIGHTS 3-5
3-3 REAR COUNTERWEIGHTS 3-6
3-4 TABLE SIDE CONTROLS 3-8
3-5 TABLE TOP REMOVAL 3-12
3-6 LONGITUDINAL AND LATERAL LOCKS 3-16
3-7 TABLE TILT DRIVE CHAIN 3-19

LIST OF FIGURES

VOLUME II

FIGURE PAGE

CHAPTER 7 - MXT-90/15 TABLE (continued)

4-1 TABLE WIRING DIAGRAM 4-2
4-2 LAYOUT FOR 5282.062.01
MILITARYITARY TABLE HE TERMINAL ASM 4-3
4-3 LAYOUT FOR 5284.062.04
POWER TOP LONG DRIVE PANEL ASM 4-5
4-4 SCHEMATIC FOR 5284.062.04
POWER TOP LONG DR PANEL ASM 4-7
4-5 LAYOUT FOR 5284.062.1801
MXT 90/15 TABLE 5 FUNCTION CONTROL SWITCH 4-8
4-6 SCHEMATIC FOR 5284.062.1801
MXT 90/15 TABLE 5 FUNCTION CONTROL SWITCH 4-10
4-7 LAYOUT FOR 5536.062.02
MILITARY TABLE\EUREKA TOWER CWT ASM 4-11
4-8 LAYOUT FOR 5736.060.04
AINSWORTH LONGITUDINAL CAR. ASM 4-13
4-9 LAYOUT FOR 5736.060.05
AINSWORTH LATERAL CARRIAGE ASM 4-18
4-10 LAYOUT FOR 5736.062.02
TABLE BODY ASM 4-21
4-11 LAYOUT FOR 5736.062.03
MILITARY R-F TABLE FRONT SKIRT ASM 4-31
4-12 LAYOUT FOR 5736.062.04
MILITARY BEARING TOP OUTER FRM ASM 4-33
4-13 LAYOUT FOR 5736.062.06
MILITARY R-F TABLE LEG ASM 4-35
4-14 LAYOUT FOR 5736.062.07
MILITARY TABLE/EUREKA ELEVATOR ASM 4-41
4-15 LAYOUT FOR 5736.062.08
MILITARY TABLE/EUREKA TOWER ASM 4-44
4-16 LAYOUT FOR 5736.062.09
MILITARY BEARING TOP INNER FRAME ASM 4-47
4-17 LAYOUT FOR 5536.009.06
TOP DRIVE CONTROL SWITCH ASM 4-51
4-18 LAYOUT FOR 5236.500.02
PATIENT HANDGRIP ASM 4-54
4-19 LAYOUT FOR 5436.504.02
UROLOGICAL RIGHT-HAND KNEE CRUTCH ASM 4-56

LIST OF FIGURES

VOLUME II

FIGURE PAGE

CHAPTER 7 - MXT-90/15 TABLE (continued)

4-20 LAYOUT FOR 5436.504.03
UROLOGICAL LEFT-HAND KNEE CRUTCH ASM 4-58
4-21 LAYOUT FOR 5536.500.01
COMPRESSION BAND DEVICE ASM 4-60
4-22 LAYOUT FOR 5536.504.01
ADJUSTABLE SHOULDER REST ASM 4-63
4-23 LAYOUT FOR 5536.504.02
FOOTREST ASM 4-66
4-24 LAYOUT FOR 9491.201
VACUUM HEAD CLAMP 4-68

CHAPTER 8 - TUBESTAND

1-1 TUBESTAND ASSEMBLY 1-2

2-1 TUBESTAND SCHEMATIC 2-3

4-1 CTC MAIN WIRING DIAGRAM 4-2
4-2 5536.101.01
CTC MAIN FRAME ASM 4-3
4-3 5536.101.02
CTC VERTICAL & LATERAL CARRIAGE ASM 4-5
4-4 5536.101.05
HORIZONTAL CARRIAGE ASM 4-8
4-5 5536.101.06
CTC VERTICAL COLUMN ASM 4-10
4-6 6810.100
FLOOR-MOUNTED TUBESTAND ASM 4-13

LIST OF FIGURES

VOLUME II

FIGURE PAGE

CHAPTER 9 - AUXILIARY BOX

1-1 AUXILIARY CIRCUIT BOX 1-2

2-1 AUXILIARY BOX WIRING DIAGRAM 2-2
2-2 TABLE TUBESTAND AUXILIARY BOX ASSEMBLY 2-3
2-3 LAYOUT FOR 6284.062.03
MXT 90/15 MAGNETIC LOCK POWER SUPPLY PCB 2-7
2-4 SCHEMATIC FOR 6284.062.03
MXT 90/15 MAGNETIC LOCK POWER SUPPLY PCB 2-9
2-5 LAYOUT FOR 6284.062.05
MXT 90/15 MOTOR CARRIAGE DRIVE PCB 2-10
2-6 SCHEMATIC FOR 6284.062.05
MXT 90/15 MOTOR CARRIAGE DRIVE PCB 2-12
2-7 LAYOUT FOR 6284.062.06
MXT 90/15 VARI-SPEED TILT CONTROL PCB 2-13
2-8 SCHEMATIC FOR 6284.062.06
MXT 90/15 VARI-SPEED TILT CONTROL PCB 2-15
2-9 LAYOUT FOR 6284.062.07
MXT 90/15 TABLE TILT CONTROL PCB 2-16
2-10 SCHEMATIC FOR 6284.062.07
MXT 90/15 TABLE TILT CONTROL PCB 2-18

CHAPTER 10 - SPOT FILM DEVICE

1.1 OUTLINE DATA 1-4

2.1 J7 WIRING 2-3
2.2 J8 WIRING 2-3
2.3 J9 WIRING 2-4

5.1 FRONT PANEL CONTROLS AND INDICATORS 5-4
5.2 FORMAT/STATUS DISPLAYS 5-7
5.3 POWER ASSIST HANDLE OPERATION 5-9

LIST OF FIGURES

VOLUME II

FIGURE PAGE

CHAPTER 10 - SPOT FILM DEVICE (continued)

6.1 CDRH/FDA COMPLIANCE TEST STAND 6-2
6.2 COMPLIANCE TEST STAND DETAIL 6-2
6.3 FLUOROSCOPIC X-RAY FIELD LIMITATION, TEST STAND METHOD 6-10
6.4 FLUOROSCOPIC X-RAY FIELD LIMITATION, DIRECT METHOD 6-13
6.5 IMAGE INTENSIFIED FLUOROSCOPE, METAL MARKER METHOD, OUTSIDE EDGE 6-13
6.6 UNDER-TABLE TUBE, TEST SET-UP 6-14
6.7 DETERMINATION OF SID 6-17
6.8 SPOTFILM X-RAY FIELD LIMITATION, TEST STAND METHOD, REFERENCE 6-18
6.9 SPOTFILM X-RAY FIELD LIMITATION, TEST STAND METHOD, ACTUAL 6-18

7.1 REAR COVER REMOVAL 7-2
7.2 FRONT COVER REMOVAL 7-3
7.3 I.I. ADAPTER PLATE REMOVAL 7-3
7.4 CHASSIS SENSOR LOCATIONS 7-4
7.5 CASSETTE PRESENT SENSOR DETAIL 7-6
7.6 LOAD POSITION SENSOR DETAIL 7-6
7.7 PARK POSITION SENSORS DETAIL 7-6
7.8 POWER SUPPLY FRONT PANEL (F4) 7-7
7.9 SIDE MOVEMENT HANDLE SENSOR DETAIL 7-8
7.10 POWER ASSIST HANDLE ADJUSTMENT 7-8
7.11 INTERFACE CIRCUIT BOARD REMOVAL 7-9
7.12 CPU CIRCUIT BOARD REMOVAL 7-9
7.13 FRONT PANEL CIRCUIT BOARD REMOVAL 7-10
7.14 DRIVESHAFT DECOUPLING 7-10
7.15 SIDE-TO-SIDE BELT TENSIONING ADJUSTMENT 7-11
7.16 MOTOR REPLACEMENT 7-11
7.17 J6 WIRING 7-12
7.18 AC INPUT TERMINAL BLOCK DETAIL 7-12
7.19 CLUTCH/BRAKE REPLACEMENT 7-13
7.20 FRONT-TO-BACK BELT TENSIONING ADJUSTMENT 7-13
7.21 CASSETTE CARRIAGE TO BELT DISASSEMBLY 7-14
7.22 SIDE-TO-SIDE FRONT IDLER PULLEY DETAIL 7-14
7.23 LEADSCREW PULLEY SETSCREW DETAIL 7-15
7.24 LEADSCREW MOUNTING BRACKET REMOVAL 7-15

8.1 SYSTEM BLOCK DIAGRAM 8-4

LIST OF FIGURES

VOLUME II

FIGURE PAGE

CHAPTER 10 - SPOT FILM DEVICE (continued)

8.2 SIMPLIFIED SCHEMATIC - KEYBOARD INTERFACE 8-8

10.1 POWER SUPPLY SCHEMATIC, 70-10416 10-5
10.2 Z80 INTERFACE BOARD ANALOG SCHEMATIC, 70-08077 10-8
10.3 Z80 INTERFACE BOARD DIGITAL SCHEMATIC, 70-08077 10-9
10.4 Z80 INTERFACE BOARD TERMINAL DESIGN, 70-08077 10-10
10.5 Z80 INTERFACE BOARD ASSEMBLY, 70-08077 10-11
10.6 Z80 CPU BOARD DIGITAL SCHEMATIC, 70-08078 10-14
10.7 Z80 CPU BOARD I/O SCHEMATIC, 70-08078 10-15
10.8 Z80 CPU BOARD ASSEMBLY, 70-07078 10-16
10.9 KEYBOARD/DISPLAY SCHEMATIC, 70-08079 10-19
10.10 KEYBOARD/DISPLAY ASSEMBLY, 70-08079 10-20

CHAPTER 11 - UNDER-TABLE COLLIMATOR

2.1 COMPONENT IDENTIFICATION 2-2
2.2 COLLIMATOR TO FOCAL SPOT DISTANCE 2-4
2.3 COLLIMATOR/TUBE MOUNTING 2-6
2.4 COLLIMATOR INTERCONNECT CABLING 2-7
2.5 J2 LOGIC WIRING 2-8
2.6 J1 LOGIC WIRING 2-9

3.1 LOGIC BOARD CALIBRATION 3-2

4.1 COLLIMATOR CENTERING 4-2
4.2 FLUOROSCOPIC I.R. SHUTTER ALIGNMENT 4-2

LIST OF FIGURES

VOLUME II

FIGURE PAGE

CHAPTER 11 - UNDER-TABLE COLLIMATOR

5.1 CDRH/FDA COMPLIANCE TEST STAND 5-2
5.2 COMPLIANCE TEST STAND DETAIL 5-2
5.3 BEAM QUALITY GRAPHING EXAMPLES 5-8
5.4 FLUOROSCOPIC X-RAY FIELD LIMITATION, TEST STAND METHOD 5-15
5.5 FLUOROSCOPIC X-RAY FIELD LIMITATION, DIRECT METHOD 5-17
5.6 IMAGE INTENSIFIED FLUOROSCOPE, TEST SET-UP 5-20
5.7 IMAGE INTENSIFIED FLUOROSCOPE, METAL MARKER METHOD, INSIDE EDGE 5-20
5.8 IMAGE INTENSIFIED FLUOROSCOPE, METAL MARKER METHOD, OUTSIDE EDGE 5-21
5.9 UNDER-TABLE TUBE, TEST SET-UP 5-21
5.10 FOCAL SPOT GEOMETRY 5-24
5.11 CALCULATION EXAMPLE 5-29
5.12 SPOTFILM X-RAY FIELD LIMITATION, TEST STAND METHOD, REFERENCE 5-30
5.13 SPOTFILM X-RAY FIELD LIMITATION, TEST STAND METHOD, ACTUAL 5-30

7.1 BLOCK DIAGRAM, ANALOG SECTION 7-2
7.2 BLOCK DIAGRAM, DIGITAL SECTION 7-3

9.1 UNDER-TABLE LOGIC PCB DIGITAL SCHEMATIC, 70-08084 9-5
9.2 UNDER-TABLE LOGIC PCB ANALOG SCHEMATIC, 70-080884 9-6
9.3 UNDER-TABLE LOGIC PCB ASSEMBLY DRAWING, 70-08084 9-7
9.4 FSE DRIVER PCB ASSEMBLY SCHEMATIC, 70-08083 9-10
9.5 FSE DRIVER PCB ASSEMBLY, 70-08083 9-11

LIST OF FIGURES

VOLUME II

FIGURE PAGE

CHAPTER 12 - OVER-TABLE COLLIMATOR

1.1 FRONT PANEL INDICATORS AND COLLIMATOR OPERATION 1-2

2.1 COMPONENT IDENTIFICATION 2-2
2.2 COLLIMATOR TO FOCAL SPOT DISTANCE 2-6
2.3 POWER CHASSIS MOUNTING DIMENSIONS 2-6
2.4 CABLING OUTLINE 2-7
2.5A,B,C TERMINAL STRIP CONNECTIONS .... 2-7 AND 2-8
2.6 EXPOSURE INTERLOCK CONNECTIONS (EXPOSURE HOLD CIRCUIT) .. 2-9
2.7 TOMO/STEREO BYPASS CONNECTIONS 2-9
2.8 CASSETTE TRAY CIRCUIT 2-9
2.9A,B HORIZONTAL SID CONNECTIONS 2-10
2.10 TABLE TILT MONITOR CONNECTIONS 2-10
2.11 TABLE TILT MONITOR CONNECTIONS 2-10

3.0 TOP AND BOTTOM COVER REMOVAL 3-2
3.1 LOGIC P.C.B. LED LOCATIONS 3-10
3.2 LOGIC P.C.B. SWITCH LOCATIONS 3-10

4.1 LIGHT FIELD VS. X-RAY FIELD CONGRUENCY 4-3
4.2 CASSETTE TRAY POTENTIOMETER WIRING 4-5
5.1 LIGHT FIELD AND BUCKY LIGHT LINE ADJUSTMENT 5-2

6.1 BRH/FDA COMPLIANCE TEST STAND 6-2
6.2 COMPLIANCE STAND DETAIL 6-2
6.3 LIGHT FIELD VS. X-RAY FIELD ERROR MEASUREMENTS 6-4
6.4 DETERMINATION OF SID 6-6
6.5 METAL MARKER METHOD 6-6
6.6 BEAM QUALITY GRAPHING EXAMPLES 6-20

9.1 COLLIMATOR HEAD MECHANICAL VIEW 9-2
9.2 BLOCK DIAGRAM 9-3
9.3 TILT SWITCH FUNCTIONS 9-5

10.1 FEEDBACK POT AND MOTOR WIRING 10-3
10.2 LOGIC BOARD SCHEMATIC (70-08080) 10-7
10.3 LOGIC BOARD ASSEMBLY (70-08080) 10-8
10.4 MASTER BOARD SCHEMATIC (70-08081) 10-11
10.5 MASTER BOARD ASSEMBLY (70-08081) 10-12
10.6 LAMP & DRIVER BOARD SCHEMATIC (70-08082) 10-15
10.7 LAMP & DRIVER BOARD ASSEMBLY (70-08082) 10-16

LIST OF FIGURES

VOLUME II

FIGURE PAGE

CHAPTER 13 - AUTOMATIC EXPOSURE CONTROL

2.1 OPERATOR CONTROLS 2-3

5.1 ADJUSTMENT COMPONENT LOCATIONS 5-3
5.2 PREAMPLIFIER ADJUSTMENT COMPONENT LOCATIONS 5-4

6.1 BASIC SYSTEM BLOCKS 6-2
6.2 FACTORY ADJUSTMENT COMPONENT LOCATIONS 6-9
6.3 MULTIPLIER GAIN ADJUSTMENT 6-14
6.4 PREAMPLIFIER ADJUSTMENT COMPONENT LOCATIONS 6-17
6.5 PREAMPLIFIER ADJUSTMENT COMPONENT LOCATIONS 6-17

SCHEMATIC DIAGRAMS

7.1 S60899B INPUT AMPLIFIER BOARD 7-1
7.2 S60900F LOGIC CONTROL BOARD 7-2
7.3 S60907D KVP COMPUTER BOARD 7-3
7.4 S60916C POWER SUPPLY BOARD 7-4
7.5 S61017C DISPLAY BOARD 7-5
7.6 WA3365A INTERCONNECTION DRAWING 7-6
7.7 S60917C THREE FIELD PREAMPLIFIER 7-7
7.8 S60940D SINGLE FIELD PREAMPLIFIER 7-8

COMPONENT LOCATION DIAGRAMS

7.9 60899B INPUT AMPLIFIER BOARD 7-9
7.10 60900F LOGIC CONTROL BOARD 7-10
7.11 60907D KVP COMPUTER BOARD 7-11
7.12 60916C POWER SUPPLY BOARD 7-12
7.13 60917C THREE FIELD PREAMPLIFIER 7-13
7.14 60940D SINGLE FIELD PREAMPLIFIER 7-14
7.15 61017C INTERNAL DISPLAY BOARD 7-15
7.16 60932C TOP BUS BOARD 7-16
7.17 60905D BOTTOM BUS BOARD 7-16
7.18 61061A DISPLAY CONNECTOR BOARD 7-16
7.19 74047A EXPOS-AID A3365 ASSEMBLY 7-17

LIST OF FIGURES

VOLUME II

FIGURE PAGE

CHAPTER 14 - IMAGE INTENSIFIER

1-1 IMAGE INTENSIFICATION SYSTEM OVERVIEW 1-2

2-1 FOCUSING ELECTRONS 2-2
2-2 IMAGE INTENSIFIER POWER SUPPLY CIRCUIT 2-3

3-1 POTENTIOMETER LOCATIONS 3-4

4-1 LAYOUT FOR 5536.822.04 MIL 6" MIRROR/LENS SUPPORT MNT ASM 4-2
4-2 LAYOUT FOR 5536.822.05 6" EUREKA/THOMSON OPTICS SPRT ASM 4-5

CHAPTER 15 - X-RAY TUBES

1-1 SINGLE PHASE, FULL WAVE, 60 HZ, 1.0 mm FOCAL SPOT RADIOGRAPHIC EXPOSURE CHART 1-2
1-2 SINGLE PHASE, FULL WAVE, 60 HZ, 2.0 mm FOCAL SPOT RADIOGRAPHIC EXPOSURE CHART 1-2
1-3 SINGLE PHASE, FULL WAVE, 60 HZ, 1.0 mm FOCAL SPOT FILAMENT EMISSION CHARTS 1-3
1-4 SINGLE PHASE, FULL WAVE, 60 HZ, 2.0 mm FOCAL SPOT FILAMENT EMISSION CHARTS 1-3
1-5 SINGLE PHASE, FULL WAVE, 50 HZ, 1.0 mm FOCAL SPOT RADIOGRAPHIC EXPOSURE CHART 1-4
1-6 SINGLE PHASE, FULL WAVE, 50 HZ, 2.0 mm FOCAL SPOT RADIOGRAPHIC EXPOSURE CHART 1-4

2-1 SINGLE PHASE, FULL WAVE, 60 HZ, 0.6 mm FOCAL SPOT RADIOGRAPHIC EXPOSURE CHART 2-2
2-2 SINGLE PHASE, FULL WAVE, 60 HZ, 1.2 mm FOCAL SPOT RADIOGRAPHIC EXPOSURE CHART 2-2
2-3 SINGLE PHASE, FULL WAVE, 60 HZ, 0.6 mm FOCAL SPOT FILAMENT EMISSION CHARTS 2-3
2-4 SINGLE PHASE, FULL WAVE, 60 HZ, 1.2 mm FOCAL SPOT FILAMENT EMISSION CHARTS 2-3
2-5 SINGLE PHASE, FULL WAVE, 50 HZ, 0.6 mm FOCAL SPOT RADIOGRAPHIC EXPOSURE CHART 2-4
2-6 SINGLE PHASE, FULL WAVE, 50 HZ, 1.2 mm FOCAL SPOT RADIOGRAPHIC EXPOSURE CHART 2-4

LIST OF FIGURES

VOLUME II

FIGURE PAGE

CHAPTER 16 - MISCELLANEOUS

1-1 LAYOUT AND PARTS LIST FOR MOBILE CASSETTE HOLDER 1-1

2-1 LAYOUT FOR LATERAL CASSETTE/GRID HOLDER 2-1

3-1 LAYOUT FOR MCT SIZE-SENSING TRAY 3-1

4-1 LAYOUT FOR RADIATION SHIELD 4-1

LIST OF TABLES

VOLUME I

TABLE PAGE

CHAPTER 1 - GENERAL

3-1 LUBRICATION SPECIFICATIONS 3-1

CHAPTER 2 - INSTALLATION

1-1 SHIPPING CRATE CONTENTS 1-5

2-1 TRANSPORT DEVICE ASM 2-3

CHAPTER 3 - CALIBRATION

2-1 KVP COMPENSATION 2-13
2-2 MINIMUM EXPOSURE TIME REQUIREMENTS AT SELECTED DISTANCES 2-19
2-3 KVP COMPENSATION WITH NON-INVASIVE METERS 2-21
2-4 TOLA ADJUSTMENTS 2-31
2-5 FILAMENT ADJUSTMENT POTS 2-47

5-1 LOGIC CHART 5-10

6-1 PHANTOM THICKNESS VS. KVP SETTING 6-9

CHAPTER 4 - TROUBLESHOOTING

NO TABLES

CHAPTER 5 - OPERATION

5-1 RESULTS OF WHOLE BODY EXPOSURE TO X-RADIATION 5-2
5-2 ESTIMATED DOSES FOR VARYING DEGREES OF INJURY 5-3

6-1 BASIC TECHNIQUES 6-2
6-2 GRID CONVERSION FACTORS 6-4
6-3 APPROXIMATE ANATOMICAL KVP RANGE 6-5

CHAPTER 6 - MXT-350 GENERATOR

2-1 AUTOTRANSFORMER TERMINAL VOLTAGES 2-3
2-2 GENERATOR CABLE FUNCTIONS 2-6
2-3 CIRCUIT BREAKER FUNCTIONS 2-7

LIST OF TABLES

VOLUME I

TABLE PAGE

CHAPTER 6 - MXT-350 GENERATOR (continued)

3-1 LINE SET ADJUSTMENTS 3-2

5-1 PARTS LIST FOR 5785.234.01
MXR-350 CONTROL 5-5
5-2 PARTS LIST FOR 5184.234.03
MXR-350 AUX TECHNIQUE PANEL ASM 5-13
5-3 PARTS LIST FOR 5184.234.0310
MXR-350 ION CHAMBER PKUP & DENSITY 5-16
5-4 PARTS LIST FOR 5184.234.0320
MXR-350 SPOTFILM CHANGEOVER PCB 5-20
5-5 PARTS LIST FOR 5184.234.04
MXR-350 MA TECH SELECT SWITCH ASM 5-23
5-6 PARTS LIST FOR 5184.234.0410
MXR-350 ION CHAMBER POWER-RESET-FIELD SWITCH 5-26
5-7 PARTS LIST FOR 5184.234.0501
MXR-350 FLUORO MA CONTROL BOARD ASM 5-29
5-8 PARTS LIST FOR 5184.234.06
MXR-350 TIMER SAFETY SWITCH ASM 5-32
5-9 PARTS LIST FOR 5184.234.0601
MXR-350 60 HZ IMPULSE TIMER RSTR ASM 5-35
5-10 PARTS LIST FOR 5184.234.0690
MXR-350 UNIVERSAL TOLA RESISTOR ASM 5-38
5-11 PARTS LIST FOR 5184.234.0698
MXR-350 UNIVERSAL BACKUP TIMER RESISTOR ASM 5-41
5-12 PARTS LIST FOR 5184.234.0699
MXR-350 50 HZ IMPULSE TIMER RESISTOR ASM 5-44
5-13 PARTS LIST FOR 5184.234.08
MXR-350 PREPARE/EXPOSE PANEL ASM 5-47
5-14 PARTS LIST FOR 5184.234.09
MXR-350 FLUORO KVP METER SHUNT ASM 5-50
5-15 PARTS LIST FOR 5184.234.10
MXR-350 FLUORO EXPOSURE INDCTR ASM 5-53

LIST OF TABLES

VOLUME I

TABLE PAGE

CHAPTER 6 - MXT-350 GENERATOR (continued)

5-16 PARTS LIST FOR 5184.234.11
MXR-350 SFD PREP DELAY RELAY ASM 5-56
5-17 PARTS LIST FOR 5184.234.12
MXR-350 SINGLE PHASE IMPULSE TIMER ASM 5-59
5-18 PARTS LIST FOR 5184.234.19
MXR-350 FILAMENT DRIVE TRANSISTOR ASM 5-63
5-19 PARTS LIST FOR 5184.234.2901
MXR-350 24VDC EXPOSURE END BUZZ ASM 5-66
5-20 PARTS LIST FOR 5281.234.02
MXR-350 TIMER SWITCH ASM 5-69
5-21 PARTS LIST FOR 5284.234.1102
MXR-350 235A 800V IMPULSE TIMER/CONTACTOR 5-71
5-22 PARTS LIST FOR 5284.234.15
MXR-350 3P FILAMENT RESISTOR PNL ASM 5-73
5-23 PARTS LIST FOR 5285.234.01
MXR-350 3P FILAMENT DRIVE COOLING ASM 5-76
5-24 PARTS LIST FOR 5285.234.02
CONSTANT VOLTAGE TRANSFORMER ASM 5-78
5-25 PARTS LIST FOR 5285.234.03
MXR-350 RESISTOR PANEL ASM 5-80
5-26 PARTS LIST FOR 5286.234.04
AUX PWR SUPPLY 50/60 HZ XFMR ASM 5-82
5-27 PARTS LIST FOR 5286.234.05
FIL. XFMR SUPPLY ASM 50/60 HZ 5-84
5-28 PARTS LIST FOR 5485.234.01
MXR-350 TAP SWITCHES PANEL ASM 5-86
5-29 PARTS LIST FOR 5585.234.02
MXR-350 CONTACTOR PANEL ASM 5-88

LIST OF TABLES

VOLUME I

TABLE PAGE

CHAPTER 6 - MXT-350 GENERATOR (continued)

5-30 PARTS LIST FOR 6184.234.0803
MXR-350 MAS METER CURRENT INTEGRATOR ASM 5-91
5-31 PARTS LIST FOR 6284.234.01
MXR-350 UNIVERSAL TOLA ASSEMBLY 5-95
5-32 PARTS LIST FOR 6284.234.02
MXR-350 AUXILIARY RELAY PANEL ASM 5-99
5-33 PARTS LIST FOR 6284.234.03
MXR-350 KVP COMPENSATION PANEL ASM 5-102
5-34 PARTS LIST FOR 6284.234.04
MXR-350 EXPOSURE INTERLOCK PANEL ASM 5-105
5-35 PARTS LIST FOR 6284.234.0803
MXR-350 BACKUP TIMER PANEL ASM 5-109
5-36 PARTS LIST FOR 6284.234.09
MXR-350 ROTOR CONTROL WITH PHOTOTRANSISTORS 5-113
5-37 PARTS LIST FOR 6284.234.1009
MXR-350 CONSTANT CURRENT FILAMENT CONTROL ASM 5-118
5-38 PARTS LIST FOR 6284.234.11
MXR-350 SCR CONTACTOR-TIMER INTERFACE 5-123
5-39 PARTS LIST FOR 6284.234.12
MXR-350 MA-KVP-LINE METER SHUNT ASM 5-127
5-40 PARTS LIST FOR 6584.234.01
MXR-350 RELAY MATRIX ASM 5-130
5-41 PARTS LIST FOR 5184.323.02
75 KVP PLUG-IN RECTIFIER ASM 5-133
5-42 PARTS LIST FOR 5484.323.02
PLUG-IN HV DIODE BRIDGE ASM 5-136
5-43 PARTS LIST FOR 6360.009
150 KV PLUG-IN RECTIFIER ASM 5-138
5-44 PARTS LIST FOR 5786.323.03
MILITARY 2-TUBE HV TRANSFORMER TOP ASM 5-140
5-45 PARTS LIST FOR 6632.300
TRANSFORMER ASSEMBLY 5-143

LIST OF TABLES

VOLUME II

TABLE PAGE

CHAPTER 7 - MXT-90/15 TABLE

4-1 PARTS LIST FOR 5282.062.01 MILITARY TABLE HE TERMINAL ASM 4-4
4-2 PARTS LIST FOR 5284.062.04 POWER TOP LONG DRIVE PNL ASM 4-6
4-3 PARTS LIST FOR 5284.062.1801 MXT 90/15 TABLE 5 FUNCTION CONTROL SWITCH 4-9
4-4 PARTS LIST FOR 5536.062.02 MILITARY TABLE/EUREKA TOWER CWT ASM 4-12
4-5 PARTS LIST FOR 5736.060.04 AINSWORTH LONGITUDINAL CARRIAGE ASM 4-14
4-6 PARTS LIST FOR 5736.060.05 AINSWORTH LATERAL CAR ASM 4-19
4-7 PARTS LIST FOR 5736.062.02 TABLE BODY ASM 4-27
4-8 PARTS LIST FOR 5736.062.03 MILITARY R-F TABLE FRNT SKIRT ASM 4-32
4-9 PARTS LIST FOR 5736.062.04 MILITARY BEARING TOP OUTER FRAME ASM 4-34
4-10 PARTS LIST FOR 5736.062.06 MILITARY R-F TABLE LEG ASM 4-36

LIST OF TABLES

VOLUME II

TABLE PAGE

CHAPTER 7 - MXT-90/15 TABLE (continued)

4-11 PARTS LIST FOR 5736.062.07
MILITARY TABLE/EUREKA ELEVATOR ASM 4-42
4-12 PARTS LIST FOR 5736.062.08
MILITARY TABLE/EUREKA TOWER ASM 4-45
4-13 PARTS LIST FOR 5736.062.09
MILITARY BEARING TOP INNER FRAME ASM 4-48
4-14 PARTS LIST FOR 5536.009.06
TOP DRIVE CONTROL SW ASM 4-52
4-15 PARTS LIST FOR 5236.500.02
PATIENT HANDGRIP 4-55
4-16 PARTS LIST FOR 5436.504.02
UROLOGICAL RIGHT-HAND KNEE CRUTCH 4-57
4-17 PARTS LIST FOR 5436.504.03
UROLOGICAL LEFT-HAND KNEE CRUTCH 4-59
4-18 PARTS LIST FOR 5536.500.01
COMPRESSION BAND DEVICE 4-61
4-19 PARTS LIST FOR 5536.504.01
ADJUSTABLE SHOULDER REST 4-64
4-20 PARTS LIST FOR 5536.504.02
FOOTREST 4-67
4-21 PARTS LIST FOR 9491.201
VACUUM HEAD CLAMP 4-69

CHAPTER 8 - TUBESTAND

4-1 PARTS LIST FOR 5536.101.01
CTC MAIN FRAME ASM 4-4
4-2 PARTS LIST FOR 5536.101.02
CTC VERTICAL & LATERAL CARRIAGE ASM 4-6
4-3 PARTS LIST FOR 5536.101.05
CTC HORIZONTAL CARRIAGE ASM 4-9
4-4 PARTS LIST FOR 5536.101.06
CTC VERTICAL COLUMN ASM 4-11
4-5 PARTS LIST FOR 6810.100
MILITARY FLOOR-MOUNTED TUBESTAND ASM 4-14

LIST OF TABLES

VOLUME II

TABLE PAGE

CHAPTER 9 - AUXILIARY BOX

2-1 PARTS LIST FOR 5785.062.01 TABLE TUBESTAND AUXILIARY BOX ASM 2-4
2-2 PARTS LIST FOR 6284.062.03 MXT 90/15 MAG LOCK POWER SUPPLY PCB 2-8
2-3 PARTS LIST FOR 6284.062.05 MXT 90/15 MOTOR CARRIAGE DRIVE ASM 2-11
2-4 PARTS LIST FOR 6284.062.06 MXT 90/15 VARI-SPEED TILT CNTRL PCB 2-14
2-5 PARTS LIST FOR 6284.062.07 MXT 90/15 TABLE TILT CONTROL PCB 2-17

CHAPTER 10 - SPOT FILM DEVICE

7.1 SYMPTOMS, CAUSES AND CURES FOR CHASSIS SENSORS 7-5

10.1 BILL OF MATERIALS EXT 950 POWER SUPPLY, 70-10416 10-3
10.2 BILL OF MATERIALS EXT Z80 INTERFACE PCB ASSEMBLY, 70-08077 10-6
10.3 BILL OF MATERIALS EXT Z80 INTERFACE BOARD ASSEMBLY, 70-08078 10-12
10.4 BILL OF MATERIALS EXT Z80 INTERFACE PCB ASSEMBLY, 70-08079 10-17

CHAPTER 11 - UNDER-TABLE COLLIMATOR

3-1 CURRENT VX. SID IN OHMS/IN. 3-12

5-1 MINIMUM BEAM QUALITY REQUIREMENTS 5-4
5-2 ALUMINUM EQUIVALENT OF PRIMARY BEAM TOTAL FILTRATION 5-5
5-3 HIGHEST DESIGN OPERATING RANGE 5-7
5-4 HALF-VALUE LAYERS AS A FUNCTION OF FILTRATION AND TUBE POTENTIAL FOR DIAGNOSTIC UNITS 5-7

8-1 TUBE MOUNTING INFORMATION 8-3

LIST OF TABLES

VOLUME II

TABLE PAGE

CHAPTER 11 - UNDER-TABLE COLLIMATOR (continued)

9-1 BILLS OF MATERIAL UNDER-TABLE LOGIC PCB ASSEMBLY, 70-08084 9-3
9-2 BILLS OF MATERIAL FSE DRIVER PCB ASSEMBLY, 70-08083 9-8

CHAPTER 12 - OVER-TABLE COLLIMATOR

2-1 CASSETTE SIZES VS. OUTPUT VOLTAGE 2-5

3-1 LINEAR II LOGIC CHART 3-9

6-1 MINIMUM BEAM QUALITY REQUIREMENTS 6-17
6-2 ALUMINUM EQUIVALENT OF PRIMARY BEAM TOTAL FILTRATION . . 6-17
6-3 HIGHEST DESIGN OPERATING RANGE 6-19
6-4 HALF-VALUE LAYERS AS A FUNCTION OF FILTRATION AND TUBE POTENTIAL FOR DIAGNOSTIC UNITS 6-19

8-1 TUBE MOUNTING INFORMATION 8-2
8-2 SIGNAL NAMES DEFINITION 8-3
8-3 40-CONDUCTOR CABLE COLOR CROSS-REFERENCE 8-4
8-4 LINEAR II LOGIC CHART 8-5
8-5 TILTING WALL BUCKY INTERFACE 8-6

10-1 BILLS OF MATERIAL - LOGIC PCB ASSEMBLY (70-08080) 10-5
10-2 BILLS OF MATERIAL - MASTER PCB ASSEMBLY (70-08081) 10-9
10-3 BILLS OF MATERIAL - LAMP & DRIVER PCB ASM (70-08082) 10-13

LIST OF TABLES

VOLUME II

TABLE PAGE

CHAPTER 13 - AUTOMATIC EXPOSURE CONTROL

5.1 KVP COMPENSATION SETTINGS 5-7

7.1 PARTS LIST 60899B INPUT AMPLIFIER BOARD 7-18
7.2 PARTS LIST 60900F LOGIC CONTROL BOARD 7-19
7.3 PARTS LIST 60907D KVP COMPUTER BOARD 7-20
7.4 PARTS LIST 60916C POWER SUPPLY BOARD 7-23
7.5 PARTS LIST 61017C DISPLAY BOARD A3365-G 7-25
7.6 PARTS LIST 60917C PRE-AMP,3-FIELD IONIZATION CHAMBER 7-27
7.7 PARTS LIST 60940D PRE-AMP,1-FIELD IONIZATION CHAMBER 7-29

CHAPTER 14 - IMAGE INTENSIFIER

4-1 PARTS LIST FOR 5536.822.04
MIL 6" MIRROR/LENS SUPPORT MNT ASM 4-3
4-2 PARTS LIST FOR 5536.822.05
6" EUREKA/THOMSON OPTICS SPRT ASM 4-6

CHAPTER 15 - X-RAY TUBES

NO TABLES

CHAPTER 16 - MISCELLANEOUS

2-1 PARTS LIST FOR LATERAL CASSETTE/GRID HOLDER 2-2

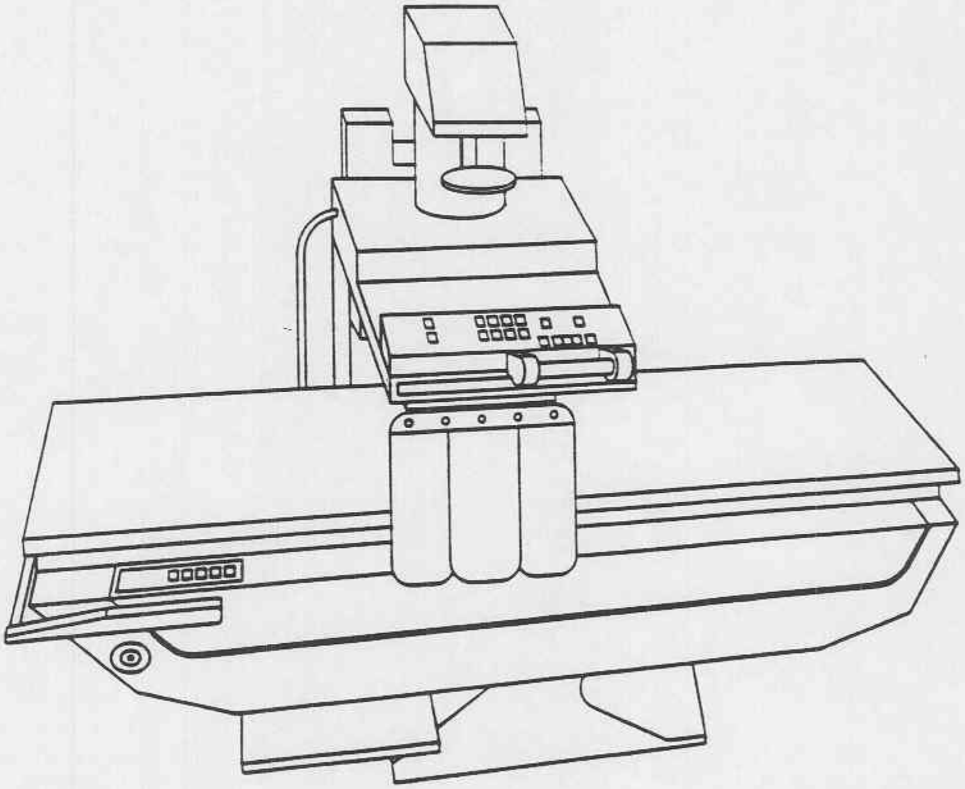
3-1 PARTS LIST FOR MCT SIZE-SENSING TRAY 3-2

4-1 PARTS LIST FOR RADIATION SHIELD 4-2

UPDATE

CHAPTER 7

TABLE



CHAPTER 7 - MXT-90/15 TABLE

TABLE OF CONTENTS

SECTION **PAGE**

SECTION 1 - GENERAL

1.1 SCOPE 1-1
1.2 TABLE DESCRIPTION 1-1
1.2.1 TABLE TOP 1-1
1.2.2 CARRIAGES AND TOWER 1-3
1.2.3 TABLE BODY 1-3
1.3 SPECIFICATIONS 1-4
1.4 ACCESSORIES 1-5
1.5 HAND TOOLS REQUIRED 1-5
1.6 TABLE OPERATION 1-6
1.7 ACCESSORY ATTACHMENT AND REMOVAL 1-6

SECTION 2 - CIRCUIT DESCRIPTION

2.1 INTRODUCTION 2-1
2.2 TABLE CIRCUIT DESCRIPTION 2-1
2.3 TABLE TOP DRIVE CONTROL 2-1
2.4 TABLE TILT CONTROL 2-4
2.5 MAGNETIC LOCK AND POWER ASSIST CIRCUITS 2-6
2.6 POWER DISTRIBUTION 2-7

SECTION 3 - MAINTENANCE

3.1 INTRODUCTION 3-1
3.2 GENERAL INSPECTION 3-1
3.3 COUNTERWEIGHT CABLE INSPECTION 3-2
3.4 OPERATIONAL CHECK 3-8
3.5 LOCK ADJUSTMENTS 3-11
3.6 TILT DRIVE CHAIN TENSION ADJUSTMENT 3-12
3.7 CLEANING 3-13
3.8 LUBRICATION 3-13
3.9 CORRECTIVE MAINTENANCE 3-13
3.9.1 TABLE TOP REMOVAL AND REPLACEMENT 3-14
3.9.2 CABLE REPLACEMENT 3-16
3.9.3 VERTICAL (COMPRESSION) LOCK REPLACEMENT . . . 3-19

TABLE OF CONTENTS (continued)

SECTION PAGE

3.9.4 TRANSVERSE (FRONT-BACK) LOCK REPLACEMENT 3-19
3.9.5 LONGITUDINAL (HEAD-FOOT) & GRID LOCKS REPLACEMENT 3-21
3.9.6 TILT DRIVE CHAIN REPLACEMENT 3-22
3.10 ADJUST TILT CONTROL MERCURY SWITCHES................. 3-22
3.11 TABLE TOP CAM ADJUSTMENT 3-25
3.11.1 TABLE TOP MOVEMENT LEFT LIMIT ADJUSTMENT 3-25
3.11.2 TABLE TOP MOVEMENT RIGHT LIMIT ADJUSTMENT 3-26
3.11.3 TABLE TOP LEFT OF CENTER POSITION ADJUSTMENT 3-28
3.11.4 TABLE TOP RIGHT OF CENTER POSITION ADJUSTMENT 3-29
3.11.5 TABLE TOP "0 INCH" POSITION (VERTICAL) ADJUSTMENT 3-31

SECTION 4 - ASSEMBLY DRAWINGS, PARTS LISTS, AND WIRING DIAGRAMS

LIST OF FIGURES

FIGURE PAGE

1-1 MXT-90/15 TABLE ASM 1-2

2-1 TABLE TOP DRIVE CONTROL CIRCUIT 2-3
2-2 TABLE TILT CONTROL 2-5
2-3 MAGNETIC LOCK CIRCUIT 2-8
2-4 POWER DISTRIBUTION 2-9

3-1 SPOT FILM DEVICE TOWER ASM 3-4
3-2 FRONT COUNTERWEIGHTS 3-6
3-3 REAR COUNTERWEIGHTS 3-7
3-4 TABLE SIDE CONTROLS 3-10
3-5 TABLE TOP REMOVAL 3-15
3-6 LONGITUDINAL AND LATERAL LOCKS 3-20
3-7 TABLE TILT DRIVE CHAIN 3-23

4-1 TABLE WIRING DIAGRAM 4-2
4-2 LAYOUT FOR 5282.062.01 TABLE HEAD END TERMINAL ASM 4-3

LIST OF FIGURES (continued)

FIGURE PAGE

4-3 LAYOUT FOR 5284.062.0401 POWER TOP LONG DRIVE PANEL ASM . 4-5
4-4 SCHEMATIC FOR 5284.062.0401 POWER TOP LONG. DRIVE PANEL . . 4-7
4-5 LAYOUT FOR 5284.062.1801 TABLE 5 FUNCTION CONTROL SWITCH 4-8
4-6 SCHEMATIC FOR 5284.062.1801 5 FUNCTION CONTROL SWITCH . . 4-10
4-7 LAYOUT FOR 5536.062.02 TABLE\SFD TOWER CWT ASM 4-11
4-8 LAYOUT FOR 5736.060.04 LONGITUDINAL CARRIAGE ASSEMBLY . . 4-13
4-9 LAYOUT FOR 5736.060.05 LATERAL CARRIAGE ASSEMBLY 4-18
4-10 LAYOUT FOR 5736.062.02 TABLE BODY ASM 4-21
4-11 LAYOUT FOR 5736.062.03 R-F TABLE FRONT SKIRT ASM 4-31
4-12 LAYOUT FOR 5736.062.04 BEARING TOP OUTER FRAME 4-33
4-13 LAYOUT FOR 5736.062.06 R-F TABLE LEG ASM 4-35
4-14 LAYOUT FOR 5736.062.07 TABLE/SFD ELEVATOR ASM 4-41
4-15 LAYOUT FOR 5736.062.08 TABLE/SFD TOWER ASM 4-44
4-16 LAYOUT FOR 5736.062.09 BEARING TOP INNER FRAME ASM . . . 4-47
4-17 LAYOUT FOR 5536.009.06 TOP DRIVE CONTROL SWITCH ASM . . 4-52
4-18 LAYOUT FOR 5236.500.02 PATIENT HANDGRIP ASM 4-55
4-19 LAYOUT FOR 5436.504.02 URO. RIGHT-HAND KNEE CRUTCH . . . 4-57
4-20 LAYOUT FOR 5436.504.03 URO. LEFT-HAND KNEE CRUTCH 4-59
4-21 LAYOUT FOR 5536.500.01 COMPRESSION BAND DEVICE ASM . . 4-61
4-22 LAYOUT FOR 5536.504.01 ADJUSTABLE SHOULDER REST ASM . 4-64
4-23 LAYOUT FOR 5536.504.02 FOOTREST ASM 4-67
4-24 LAYOUT FOR 9491.201 VACUUM HEAD CLAMP 4-69
4-25 TABLE HIGH VOLTAGE CABLE SUPPORT BAND 4-71

LIST OF TABLES

TABLE PAGE

4-1 PARTS LIST FOR 5282.062.01 TABLE HEAD END TERMINAL ASM . . 4-4
4-2 PARTS LIST FOR 5284.062.0401 POWER TOP LONG.DRIVE ASM . . 4-6
4-3 PARTS LIST FOR 5284.062.1801 5 FUNCTION CONTROL SWITCH . 4-9
4-4 PARTS LIST FOR 5536.062.02 TABLE/SFD TOWER CWT ASM 4-12
4-5 PARTS LIST FOR 5736.060.04 LONGITUDINAL CARRIAGE ASM . . 4-14
4-6 PARTS LIST FOR 5736.060.05 LATERAL CARRIAGE ASM 4-19
4-7 PARTS LIST FOR 5736.062.02 TABLE BODY ASM 4-27
4-8 PARTS LIST FOR 5736.062.03 R-F TABLE FRONT SKIRT ASM 4-32

LIST OF TABLES (continued)

TABLE PAGE

4-9 PARTS LIST FOR 5736.062.04 BEARING TOP OUTER FRAME ASM 4-34
4-10 PARTS LIST FOR 5736.062.06 R-F TABLE LEG ASM 4-36
4-11 PARTS LIST FOR 5736.062.07 TABLE/SFD ELEVATOR ASM 4-42
4-12 PARTS LIST FOR 5736.062.08 TABLE/SFD TOWER ASM 4-45
4-13 PARTS LIST FOR 5736.062.09 BEARING TOP INNER FRAME ASM . 4-48
4-14 PARTS LIST FOR 5536.009.06 TOP DRIVE CONTROL SWITCH ASM 4-53
4-15 PARTS LIST FOR 5236.500.02 PATIENT HANDGRIP 4-56
4-16 PARTS LIST FOR 5436.504.02 UROLOGICL RIGHT KNEE CRUTCH . 4-58
4-17 PARTS LIST FOR 5436.504.03 UROLOGICL LEFT KNEE CRUTCH . 4-60
4-18 PARTS LIST FOR 5536.500.01 COMPRESSION BAND DEVICE . . . 4-62
4-19 PARTS LIST FOR 5536.504.01 ADJUSTABLE SHOULDER REST . . 4-65
4-20 PARTS LIST FOR 5536.504.02 FOOTREST 4-68
4-21 PARTS LIST FOR 9491.201 VACUUM HEAD CLAMP 4-70
4-22 PARTS LIST FOR TABLE HIGH VOLTAGE CABLE SUPPORT BAND ASSEMBLY 4-72

CHAPTER 7 - MXT-90/15 TABLE

SECTION 1 - GENERAL

1.1 SCOPE

This chapter describes the maintenance of the MXT-90/15 Radiographic/Fluoroscopic Table.

The table is part of a radiology system consisting of the table, an x-ray generator, tubestand, two x-ray tubes, spot film device, under-table and over-table collimators, and an imaging system. The floor-mounted tubestand allows positioning of the over-table x-ray tube and collimator.

These components are the subjects of their own texts and will not be discussed except as applies to the table.

1.2 TABLE DESCRIPTION

The MXT-90/15 Radiologic/Fluoroscopic Table is a heavy duty table for radiographic and fluoroscopic examinations (**FIGURE 1-1**).

It consists of a 2-way movable table top, carriages, tower and base. The table can be tilted to any angle between +88° and -12° Trendelenburg at a rate of 4.5° per second.

1.2.1 TABLE TOP

The power-driven 2-way table top is capable of supporting patients weighing up to 300 pounds (136 kg).

It is constructed of a steel frame with a radiographic translucent non-staining white surface panel.

It moves 30" (76.2 mm) from center toward either end of the table for a total longitudinal (head-foot) range of 60" (152.4 cm). Interlocks prevent the extended top from striking the floor or ceiling when the table is tilted.

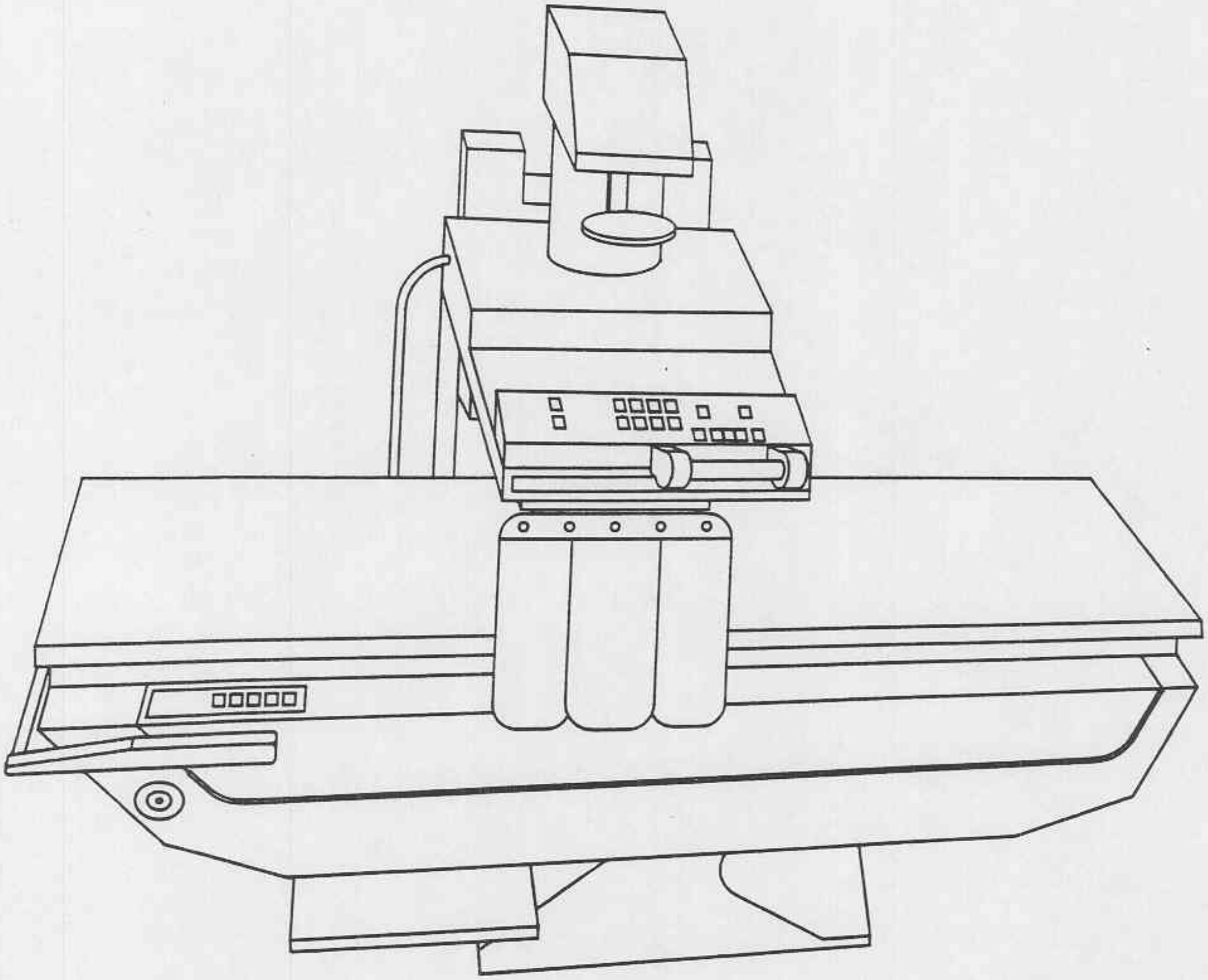


FIGURE 1-1 MXT-90/15 TABLE ASSEMBLY

1.2.2 CARRIAGES AND TOWER

The table has both a longitudinal and transverse carriage, allowing a wide area for patient positioning.

Both carriages ride on adjustable precision bearings and are counterbalanced in all positions. Longitudinal movement is power-assisted.

The tower holds a vertical carriage to support the spot film device and image intensifier.

Electrical circuitry in the carriage enables the spot film device and under-table collimator to automatically adjust to source-to-image distances (SIDs) in the range of the vertical carriage.

A myelographic stop is included to limit the travel of the vertical carriage, when required for patient safety.

All carriages have electromagnetic locks to prevent movement when engaged.

Momentary push buttons control the motor-driven top and table tilt motions and are located on the table skirt near the head end.

A gravity-operated angulation gauge is located on the table front.

A retractable foot step is also attached near the head end of table body, as a convenience to patients.

1.2.3 TABLE BODY

The table body is fully enclosed by a welded steel construction.

The table has a hinged fluoroscopic radiation shield (with 1 mm lead equivalency) and extends 5" (127 mm) above the table top when in use.

1.3 TABLE SPECIFICATIONS

Physical dimensions:	
table base	32-1/4" x 34-5/8" (820 mm X 880 mm)
table body	30" x 81" (762 mm X 2,057 mm)
table top height	34-1/2" (876.3 mm, table horizontal)
Grid cabinet:	
dimensions	23" L X 18-1/2" W (584.2 mm x 470 mm)
grid type	Fixed, 150 line
Electrical power requirements:	115 volts AC, 8 amps, 50/60 Hz
Shipping weight:	2,264 lb. (1,027 kg)
Operational environment:	
temperature range	32°F - 122°F (0°C - 50°C)
humidity range	0% - 100%
Table tilt:	
range	+88° to -12°
rate	4.5° per second
focal point-to-table top:	17" ±1/4" (457 mm ±6 mm)
focal point-to-shutters:	
upper shutter	9.22" ±1/4" (234 mm ±6 mm)
lower shutter	8.58" ±1/4" (217.1 mm ±6 mm)
focal point-to-floor: (table distance vertical)	27-3/16" to 64-3/16" (690 mm to 1630 mm)
tube transverse travel:	5-3/4" (146 mm) center to front, plus 5-3/4" center to back (11-1/2" or 292 mm, total)

1.3 TABLE SPECIFICATIONS (continued)

table longitudinal travel:	30" (762 mm) from center to head end and 30" from center to foot end (60" or 1524 mm, total)
maximum patient weight:	300 pounds (136 KG)

1.4 ACCESSORIES

Footrest

Shoulder rest

Patient hand grips

Compression band device

Urological knee crutches

Lateral cassette holder

Head holder

1.5 HAND TOOLS REQUIRED

Torque wrench capable of measuring at least
    11 foot-pounds
Slotted screwdrivers
No.1 and No.2 phillips screwdrivers
Needle-nosed pliers
Set of SAE open/box end wrenches
6" (150 mm) adjustable wrench
Flat pry bar, 18" - 24" long (455 mm - 610 mm)
Inspection mirror
Shimming block(s)

1.6 TABLE OPERATION

For operation of the MXT-90/15 radiographic/fluoroscopic table from the spot film device or table side controls, refer to the Operation chapter, Chapter 5, in Volume One of this manual.

1.7 ACCESSORY ATTACHMENT AND REMOVAL

A full complement of easily attached and removed accessories is supplied with the MXT-90/15 table.

The installation and removal of these accessories is covered in Chapter 5 - Operation, of this manual.

Parts lists for the accessories are located at the end of this chapter.

SECTION 2 - CIRCUIT DESCRIPTION

2.1 INTRODUCTION

This section describes the electrical circuitry used in the MXT-90/15 radiological/fluoroscopic table. Much of this circuitry is mounted on printed circuit boards.

The schematic diagrams of the circuitry are in this chapter. Refer to them as needed, while reading the circuit descriptions.

2.2 TABLE CIRCUIT DESCRIPTION

The table circuitry consists of three sections;

top drive control
variable speed tilt control
the magnetic lock circuit.

Power is distributed to the table circuitry through circuit breakers.

2.3 TABLE TOP DRIVE CONTROL (FIGURE 2-1)

The Table Top Drive Control circuit consists of a 90 volts DC permanent magnet motor, and a 90 volts DC power supply to provide its operating voltage.

Power supply operation is controlled by K1, K2, K3, K4, and K5 as determined by the front panel Top Head and Top Foot push buttons, or the spot film device Top Head and Top Foot switches.

Two mercury switches SW11 and SW12, relay K6 and K7, and time delay relays Delay 1 and Delay 2, as well as several cam actuated microswitches, are also part of the Power Supply Control circuitry.

In **FIGURE 2-1**, all relays are shown in the relaxed state. AC voltage is applied to the diode bridge (D1) whenever a table top move command is initiated, and thus applies DC voltage to the table top drive motor.

Table top movement is generated when either Top Foot, Top Center or Top Head switches are depressed.

2.3 TABLE TOP DRIVE CONTROL (continued)

When the front panel, or the spot film device Top Head, push button switch is pressed, relay K4 energizes closing ZLR to ZAR.

ZAR is routed through the right limit switch. If the top is not at the right limit, ZDR will energize K2.

K2 contacts apply AC power to bridge D1, which results in DC power applied to the motor.

K2 will work in this manner as long as the table is not tilted more than 20° to the right or 34° to the left.

In either case, mercury switches (SW11 and SW12) will open and result in LR of K2 coil to float, which prevents application of power to ZDR of K2 coil to energize K2.

When the Top Head push button is pressed, power is applied to ZLL, which energizes K3.

When K3 is energized, ZLL closes to ZAL.

Provided the table top is not at the left limit, ZAL is closed to ZDL which energizes K1.

K1 has the opposite effect as K2, applying power to the motor in the opposite polarity, and moving the table to the left.

K1 will work in this manner as long as the table is not tilted more than 34° to the right.

If the table is tilted more than 34° to the right, SW11 opens and deenergizes relay K6 and LL1 will no longer be connected to neutral; thus, K1 will not energize when ZDL is applied.

When the Top Center push button is depressed, power is applied to TCC and K5 is energized.

Power is then applied to both K4 and K3, enabling either right or left movement.

K1 or K2 is then energized depending on the right of center or left of center cam limit switch.

If the top is right of center, the right of center switch will be open, LR will be floating, and K2 cannot energize.

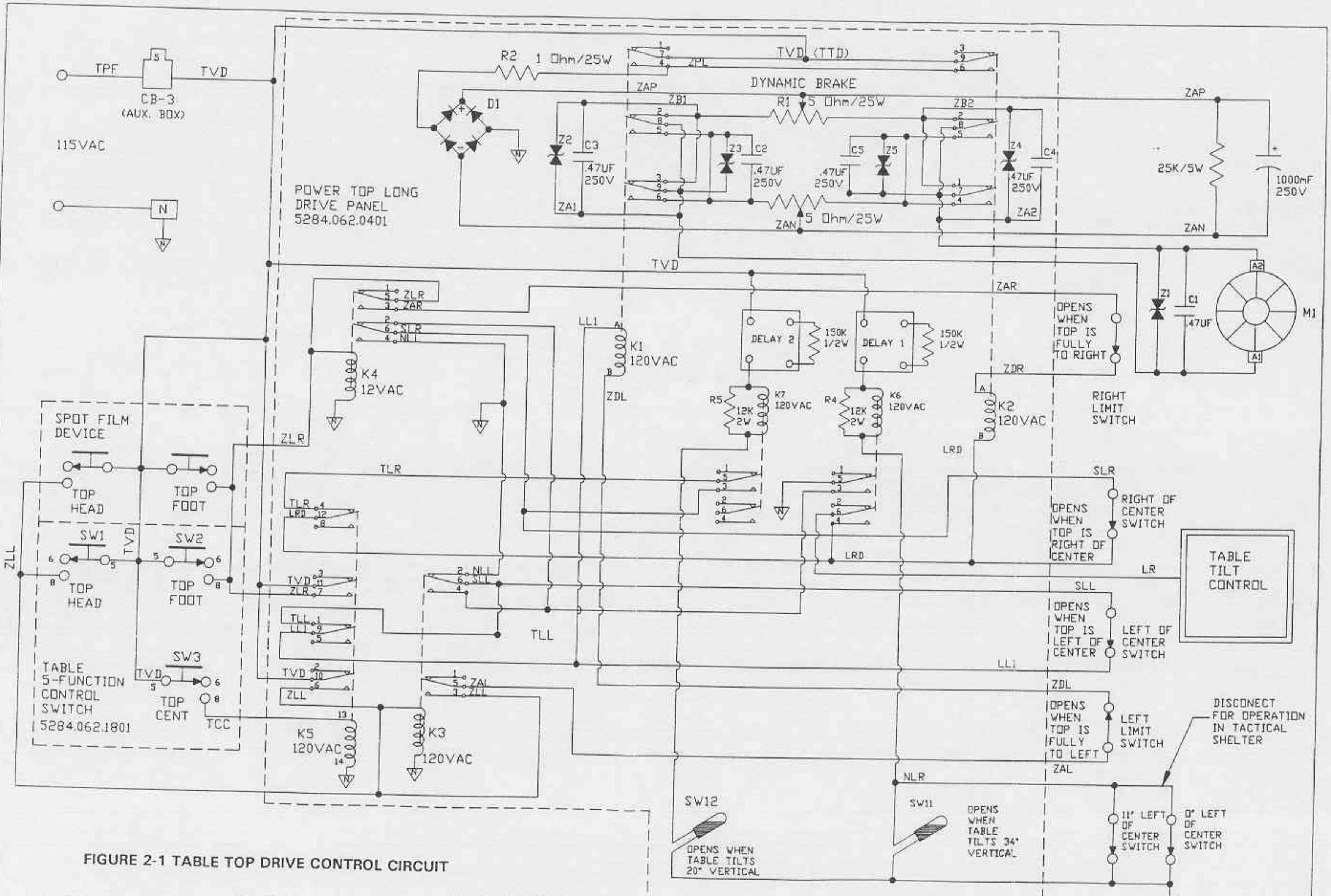

TPF
CB-3
(AUX. BOX)
TVD
115VAC
N
POWER TOP LONG
DRIVE PANEL
5284.062.0401
R2 1 Ohm/25W
TVD (TTD)
ZPL
ZAP
DYNAMIC BRAKE
D1
ZB1
R1 5 Ohm/25W
ZB2
Z2
C3
.47UF
250V
Z3
C2
.47UF
250V
C5
Z5
.47UF
250V
Z4
C4
.47UF
250V
ZA1
ZAN
5 Ohm/25W
ZA2
ZAP
25K/5W
1000mF
250V
ZAN
TVD
ZLR
ZAR
SLR
NLR
K4
12VAC
LL1
K1
120VAC
ZDL
DELAY 2
150K
1/2W
DELAY 1
150K
1/2W
R5
12K
2W
K7
120VAC
R4
12K
2W
K6
120VAC
ZAR
ZDR
K2
120VAC
LRD
OPENS
WHEN
TOP IS
FULLY
TO RIGHT
RIGHT
LIMIT
SWITCH
Z1
C1
.47UF
A2
A1
M1
SPOT FILM
DEVICE
TOP
HEAD
TOP
FOOT
ZLR
TLR
TLR
LRD
SW1
SW2
TVD
ZLL
TOP
HEAD
TOP
FOOT
TVD
ZLR
NLL
SLL
TLL
LL1
TLL
LRD
SLR
OPENS
WHEN
TOP IS
RIGHT OF
CENTER
RIGHT OF
CENTER
SWITCH
TABLE
TILT
CONTROL
LR
SLL
OPENS
WHEN
TOP IS
LEFT OF
CENTER
LEFT OF
CENTER
SWITCH
LL1
TABLE
5-FUNCTION
CONTROL
SWITCH
5284.062.1801
SW3
TVD
TOP
CENT
TCC
TVD
ZLL
ZAL
ZLL
K5
120VAC
K3
120VAC
ZDL
OPENS
WHEN
TOP IS
FULLY
TO LEFT
LEFT
LIMIT
SWITCH
ZAL
DISCONECT
FOR OPERATION
IN TACTICAL
SHELTER
NLR
SW12
OPENS WHEN
TABLE TILTS
20° VERTICAL
SW11
OPENS
WHEN
TABLE
TILTS 34°
VERTICAL
11° LEFT
OF
CENTER
SWITCH
0° LEFT
OF
CENTER
SWITCH

FIGURE 2-1 TABLE TOP DRIVE CONTROL CIRCUIT

2.3 TABLE TOP DRIVE CONTROL (continued)

The left of center switch is closed and LL1 is connected to neutral through NLL. K1 energizes and the table top moves left.

Alternatively, if the top is left of center, the left of center switch will be open, LL1 floats, and K1 cannot energize.

The right of center switch is closed, K2 energizes, and the top moves right.

2.4 TABLE TILT CONTROL (FIGURE 2-2)

When the Trendelenburg switch on the table or spot film device is pressed, TDE goes high (115 volts AC) to K1-11,12 on the table tilt control panel.

115 volts AC then goes to the Trendelenburg limit switch as TD and returns as TLS.

TLS goes to the interlock relay in the head end of the table and comes out as TLR.

This relay is an inhibit, preventing table motion when:

the foot step is not in home position,

the spot film device is not near the foot end,

or the table is more than 3° horizontal or less than 68° above horizontal.

TLR goes to the Tilt Down contactor, which applies DC power to the motor to tilt the table Trendelenburg.

When the vertical switch on the table or spot film device is pressed, TUE goes high (115 volts AC) to K3-11, 12.

115 volts AC then goes out to the vertical limit switch as TU and comes out as TRS. TRS goes to the Interlock relay in the head end of the table and comes out as TRR.

This relay is an inhibit preventing table motion when:

the foot step is not in home position,

the spot film device is not near the foot end,

or the table is more than 3° horizontal or less than 68° above horizontal.

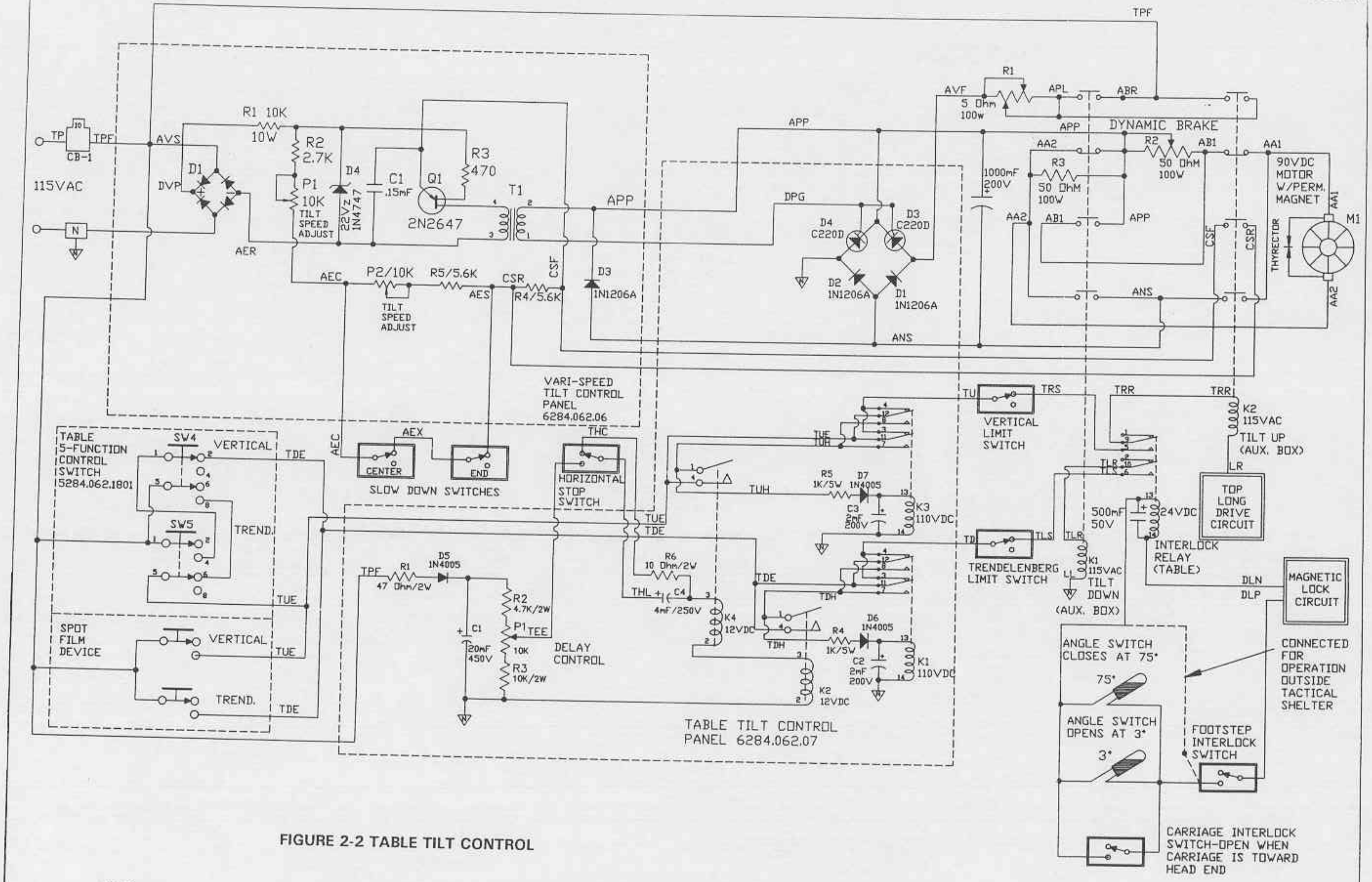

TPF
TP
CB-1
10
115VAC
N
AVS
DVP
D1
AER
R1 10K 10W
R2 2.7K
P1 10K TILT SPEED ADJUST
D4 22Vz 1N4747
C1 .15mF
Q1 2N2647
R3 470
T1
APP
AEC
P2/10K TILT SPEED ADJUST
R5/5.6K
AES
CSR
R4/5.6K
CSF
D3 1N1206A
DPG
D4 C220D
D3 C220D
D2 1N1206A
D1 1N1206A
ANS
VARI-SPEED TILT CONTROL PANEL 6284.062.06
AVF
R1 5 Ohm 100w
APL
ABR
DYNAMIC BRAKE
AA2
R2 50 Ohm 100W
AB1
AA1
R3 50 Ohm 100W
1000mF 200V
AB1
90VDC MOTOR W/PERM. MAGNET
THYRECTOR
M1
AEX
CENTER
END
SLOW DOWN SWITCHES
THC
HORIZONTAL STOP SWITCH
TABLE 5-FUNCTION CONTROL SWITCH 5284.062.1801
SW4
VERTICAL
TDE
SW5
TREND.
TUE
SPOT FILM DEVICE
VERTICAL
TREND.
TUE
TDE
TPF
R1 47 Ohm/2W
D5 1N4005
C1 20mF 450V
R2 4.7K/2W
P1 10K
TEE
R3 10K/2W
DELAY CONTROL
TUH
THL
C4 4mF/250V
R6 10 Ohm/2W
K4 12VDC
R5 1K/5W
D7 1N4005
C3 2mF 200V
K3 110VDC
TDH
R4 1K/5W
D6 1N4005
C2 2mF 200V
K1 110VDC
K2 12VDC
TABLE TILT CONTROL PANEL 6284.062.07
TU
TRS
VERTICAL LIMIT SWITCH
TD
TLS
TRENDELENBERG LIMIT SWITCH
TLR
K1 115VAC TILT DOWN (AUX. BOX)
TRR
K2 115VAC TILT UP (AUX. BOX)
LR
TOP LONG DRIVE CIRCUIT
500mF 50V
24VDC
INTERLOCK RELAY (TABLE)
DLN
DLP
MAGNETIC LOCK CIRCUIT
ANGLE SWITCH CLOSES AT 75°
75°
ANGLE SWITCH OPENS AT 3°
3°
CONNECTED FOR OPERATION OUTSIDE TACTICAL SHELTER
FOOTSTEP INTERLOCK SWITCH
CARRIAGE INTERLOCK SWITCH-OPEN WHEN CARRIAGE IS TOWARD HEAD END

FIGURE 2-2 TABLE TILT CONTROL

SEE ADJACENT FOLDOUT FOR THIS PAGE.

FIGURE 2-2 TABLE TILT CONTROL

2.4 TABLE TILT CONTROL (continued))

TRR goes to the Tilt Up contactor, which applies DC power to the motor to tilt the table vertical.

When the table reaches horizontal from either Trendelenburg or vertical, the horizontal stop switch energizes relays K2 and K4, which open either the TUE or TDE circuit.

Either the Center Slow Down Limit switch, or the End Slow Down Limit switch, will open when the table reaches the corresponding position.

This will open the short circuit between AEC and AES. This will cause R5 to reduce the charging current to C1, which pulses Q1 on once for each AC 1/2 cycle.

This delays turn on of SCRs D3 and D4 during each AC power 1/2 cycle.

This reduces the power to the tilt motor resulting in slow down.

2.5 MAGNETIC LOCK AND POWER ASSIST CIRCUITS (FIGURE 2-3)

All locks are released with no power applied. Power must be applied to the table before locks can be engaged.

The locks receive their operating power from a single 18 volt DC power supply.

The remainder of the circuitry consists of the locks, one relay, and three switches for controlling operation.

Each of the magnetic locks is controlled through a lock switch on either the spot film device or the grid cabinet.

Additionally, activation of the power assist handle on the spot film device will activate RE-1 and remove power from the lateral and longitudinal locks.

The power assist handle also activates RE-2 when activated to the head-end, and RE-1 when activated to the foot-end.

This causes the appropriate polarity of the DC power to be supplied to the motor through bridge D1, resulting in carriage power assist.

2.6 POWER DISTRIBUTION (FIGURE 2-4)

The generator main control autotransformer supplies 115 volts AC to the table through main circuit breaker CB1.

Most of the table circuits are protected by their own circuit breakers;

> a 5 amp breaker protects the Table Top Drive Circuit;
>
> the table carriage power assist and spot film device are each protected by a 3 amp breaker;
>
> and the lock circuits are equipped with a 1 amp breaker.

The tilt control circuit is protected directly by CB-1.

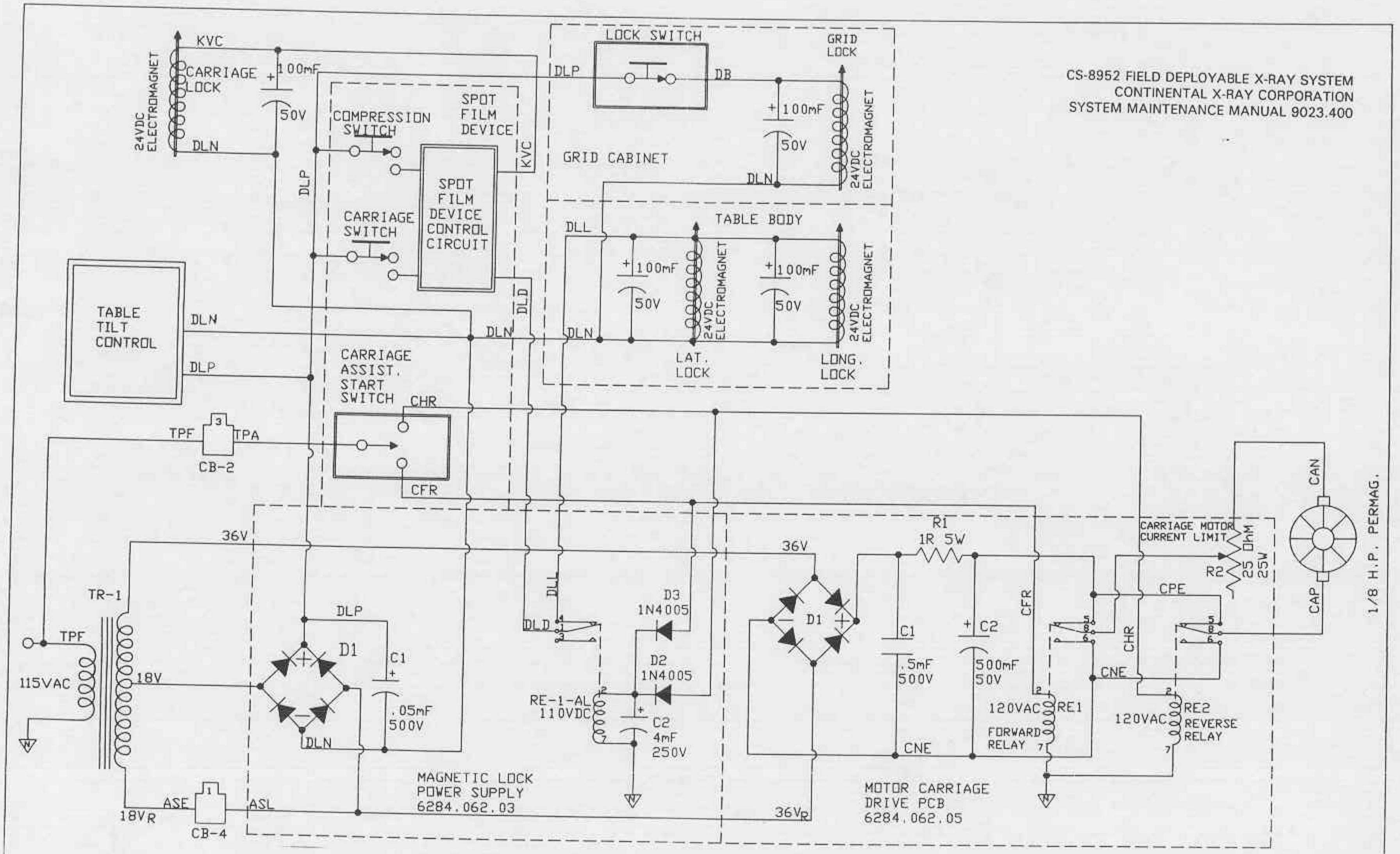

KVC
CARRIAGE LOCK
24VDC ELECTROMAGNET
DLN
100mF
50V
DLP
COMPRESSION SWITCH
SPOT FILM DEVICE
KVC
SPOT FILM DEVICE CONTROL CIRCUIT
CARRIAGE SWITCH
DLD
LOCK SWITCH
DB
GRID LOCK
24VDC ELECTROMAGNET
GRID CABINET
DLL
TABLE BODY
LAT. LOCK
LONG. LOCK
TABLE TILT CONTROL
CARRIAGE ASSIST. START SWITCH
CHR
CFR
TPF
TPA
3
CB-2
36V
TR-1
115VAC
18V
18V_R
ASE
ASL
1
CB-4
D1
C1
.05mF
500V
MAGNETIC LOCK POWER SUPPLY
6284.062.03
D3
1N4005
D2
1N4005
RE-1-AL
110VDC
C2
4mF
250V
R1
1R 5W
.5mF
500V
500mF
50V
CNE
120VAC
RE1
FORWARD RELAY
RE2
REVERSE RELAY
CARRIAGE MOTOR CURRENT LIMIT
R2
25 OHM
25W
CPE
CAN
CAP
1/8 H.P. PERMAG.
36V_R
MOTOR CARRIAGE DRIVE PCB
6284.062.05

FIGURE 2-3 MAGNETIC LOCK CIRCUIT

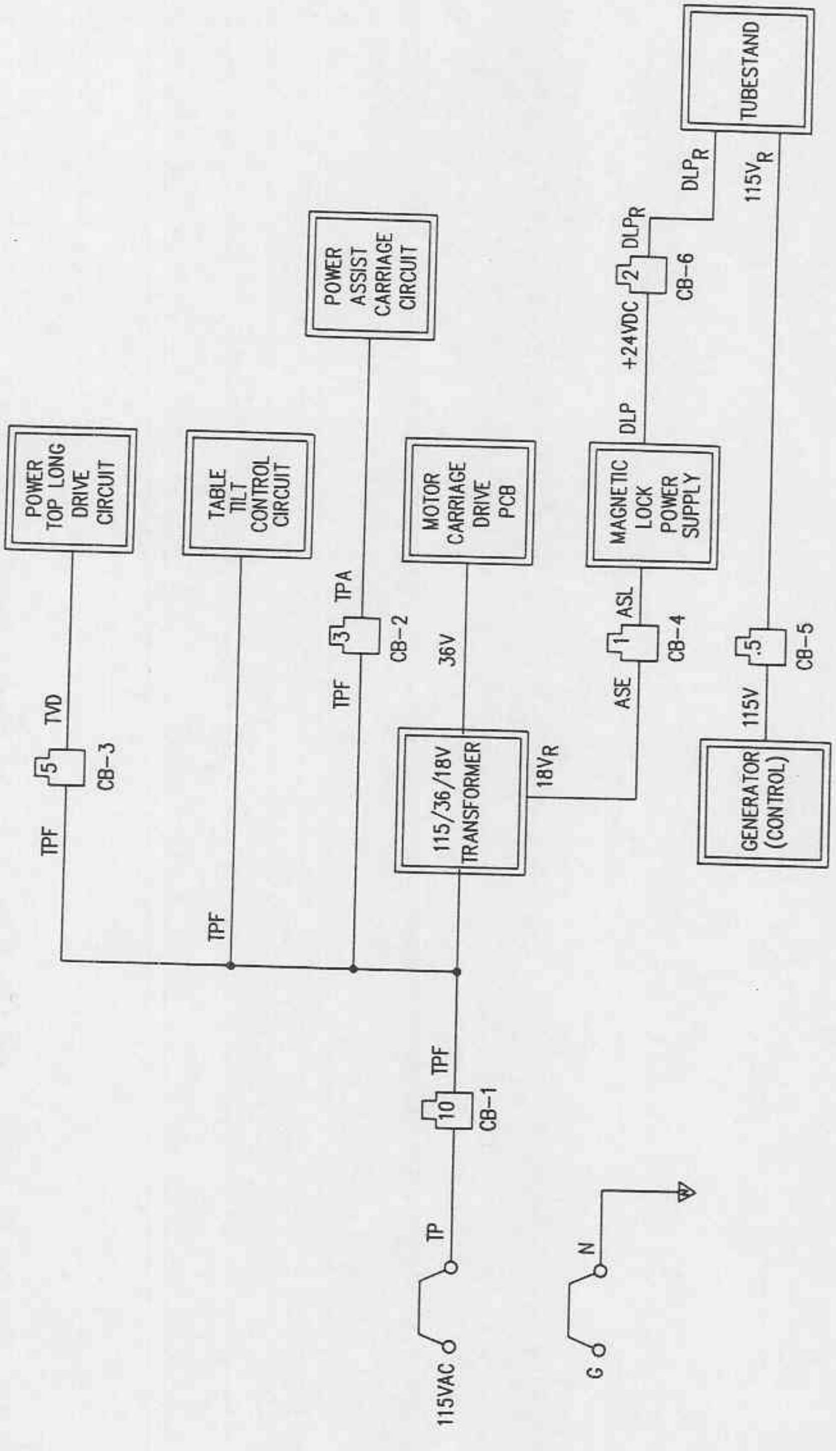

115VAC
TP
G
N
CB-1
10
TPF
TPF
CB-3
5
TVD
POWER TOP LONG DRIVE CIRCUIT
TPF
TABLE TILT CONTROL CIRCUIT
TPF
CB-2
3
TPA
POWER ASSIST CARRIAGE CIRCUIT
115/36/18V TRANSFORMER
36V
MOTOR CARRIAGE DRIVE PCB
18V_R
ASE
CB-4
1
ASL
MAGNETIC LOCK POWER SUPPLY
DLP
+24VDC
CB-6
2
DLP_R
DLP_R
GENERATOR (CONTROL)
115V
CB-5
.5
115V_R
TUBESTAND

FIGURE 2-4 POWER DISTRIBUTION

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SECTION 3 - MAINTENANCE

3.1 INTRODUCTION

Maintenance for the MXT-90/15 radiographic/fluoroscopic table falls into two basic categories: preventive and corrective.

Some preventive maintenance procedures are performed by operators.

The information in this section is intended for use by a Medical Equipment Repairer.

3.2 GENERAL INSPECTION

When inspecting the MXT-90/15 table, be sure to:

1. Check all nuts and bolts, screws, rivets, and other fasteners to be sure that they are tight. Also insure that all fasteners are present and in good condition.

2. Inspect all electrical cables, cords, connectors, and fittings for tightness.

   Check for breaks in the insulation, abrasions, and other damage to cables and connectors.

   Pay particular attention to areas where electrical cabling enters housings. It may be subject to stress from table positioning and other mechanical motions.

3. Examine all exterior painted or plated surfaces for evidence of deterioration, such as scratches, chipping, and corrosion.

   Insure that all name plates and warning labels are present, legible, and securely mounted.

3.3 COUNTERWEIGHT CABLE INSPECTION

The MXT-90/15 table uses high tensile strength aircraft control cables in the counterbalancing system.

In normal use, these stranded steel cables are subject to wear that could affect system safety.

The cables should be inspected no less than every six months - more often in heavily used systems.

The importance of this inspection cannot be overemphasized.

WARNING:

A cable failure can cause serious patient or operator injury or equipment damage.

This is especially true of the spot film device vertical counterbalancing system in the tower.

Worn or damaged cables cannot be repaired.

They must be immediately replaced if there is any evidence of broken or frayed strands, kinks, corrosion other than on the surface, or weakness in any mechanical fitting.

The cable replacement procedure is in Section 3.9.2.

To perform this inspection, proceed as follows:

1. Remove the back cover from the tower.
2. Move the spot film device to its highest possible vertical position.

3.3 COUNTERWEIGHT CABLE INSPECTION (continued)

3. Notice in **FIGURE 3-1** that the vertical carriage is connected to the sides of the counterweight holder by means of two cables; one at each end.

Visually inspect both of these cables, looking for evidence of kinks.

Kinks usually result from twisting and appear as strand separation and distortion in the shape of the cable.

4. Inspect the cables for evidence of rust or corrosion.

Light surface rust and corrosion can be removed without replacing a cable.

The cable must be replaced if rust or corrosion has penetrated its interior.

5. Examine the attachments at both ends of the cables.

Make sure that there is no evidence of kinking and that all mechanical fittings are sound.

6. Inspect for broken strands by running a soft cloth such as a towel, along the entire length of both cables, including the points of attachment to the counterweight holder.

If the cloth snags at any location along the cable's length, it indicates that strands are broken.

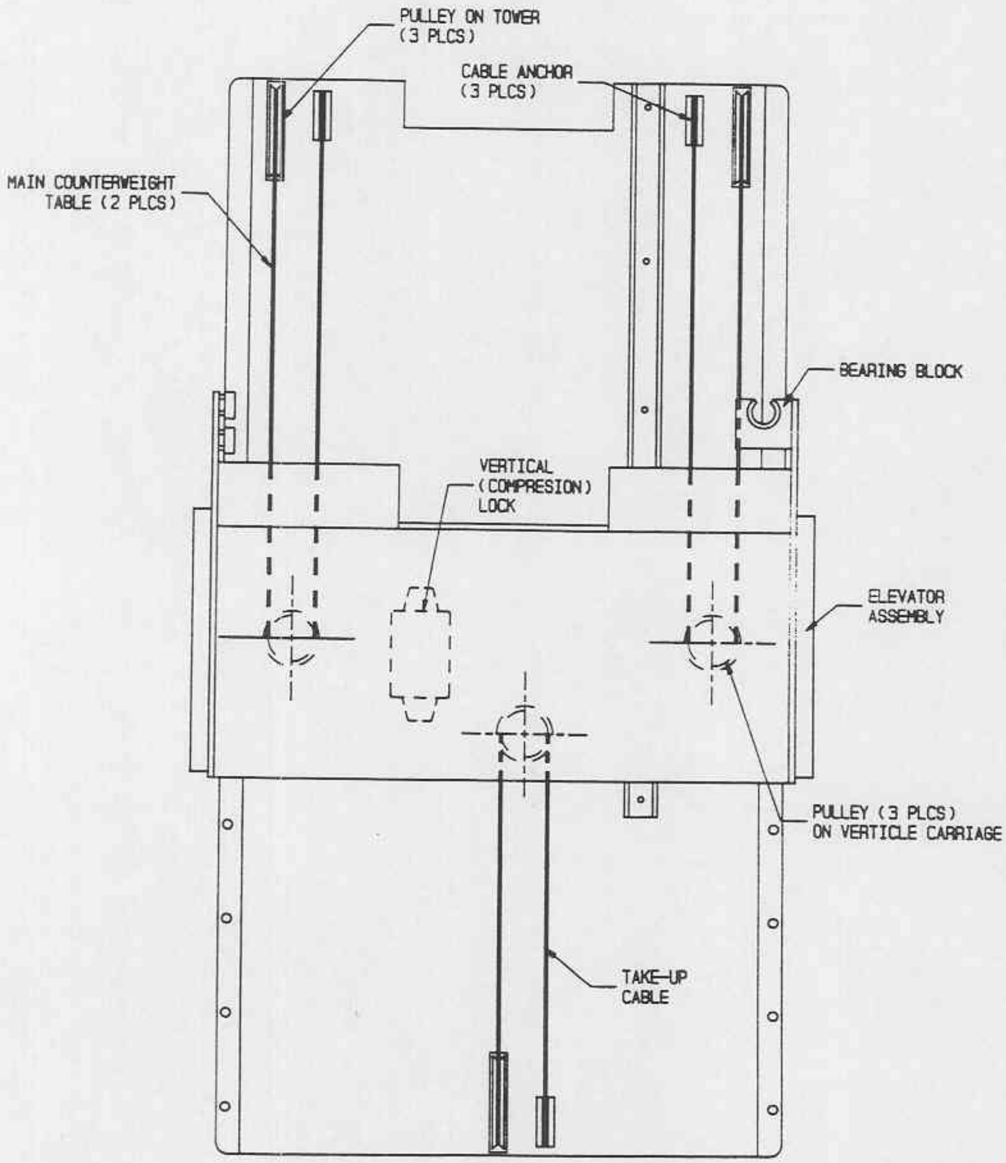
PULLEY ON TOWER (3 PLCS)
CABLE ANCHOR (3 PLCS)
MAIN COUNTERWEIGHT TABLE (2 PLCS)
BEARING BLOCK
VERTICAL (COMPRESION) LOCK
ELEVATOR ASSEMBLY
PULLEY (3 PLCS) ON VERTICLE CARRIAGE
TAKE-UP CABLE

FIGURE 3-1 SPOT FILM DEVICE TOWER ASSEMBLY

3.3 COUNTERWEIGHT CABLE INSPECTION (continued)

7. Move the spot film device to its lowest possible position.

A third cable is attached to the counterweight holder at the center bottom.

Inspect this cable by following the procedure described above.

8. Remove the table top, following the procedure in **Section 3.9.1**.

9. Inspect all cables for rust or corrosion, kinks, and broken strands, as already described.

Check all fittings at the point of attachment on all cables (**FIGURE 3-2** and **3-3**).

10. Replace all covers after the cables have been inspected or replaced.

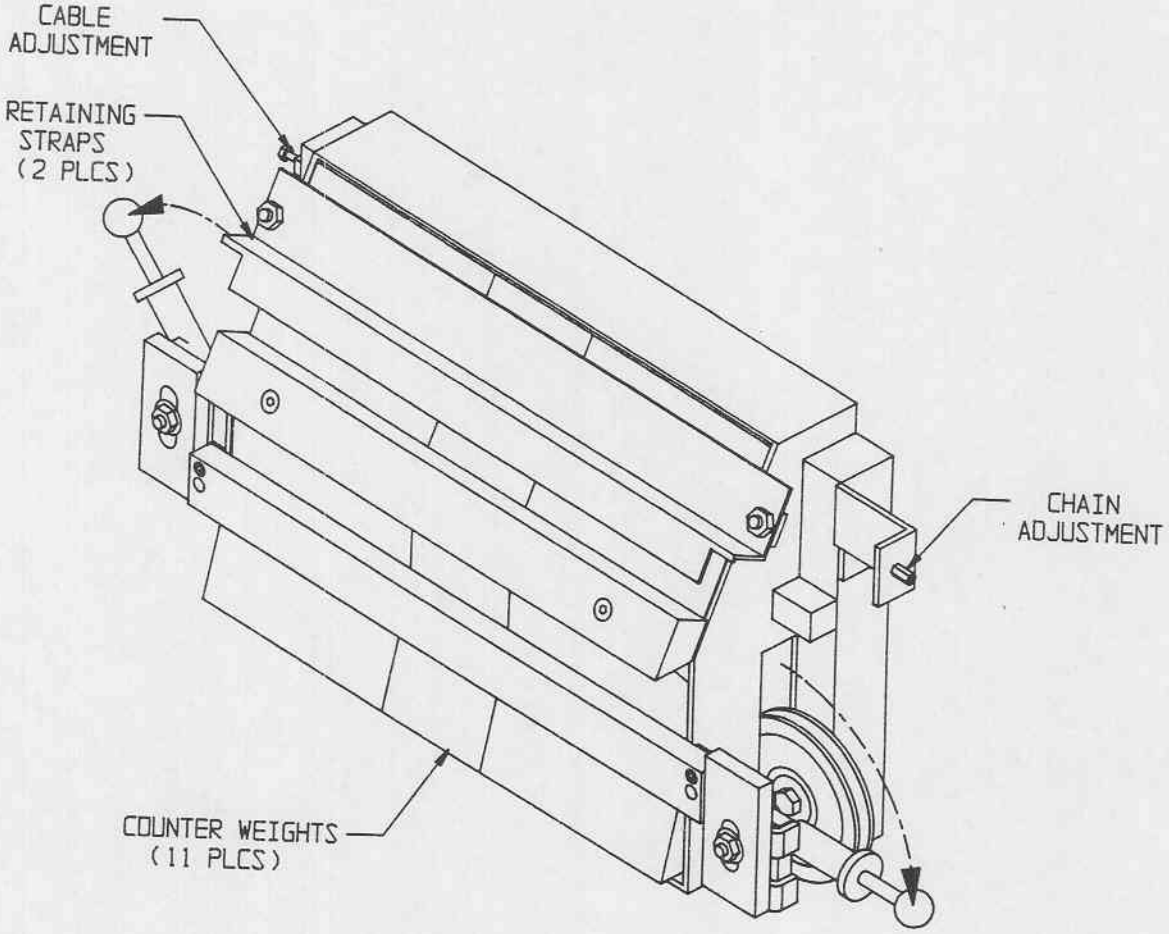
CABLE ADJUSTMENT
RETAINING STRAPS (2 PLCS)
CHAIN ADJUSTMENT
COUNTER WEIGHTS (11 PLCS)

FIGURE 3-2 FRONT COUNTERWEIGHTS

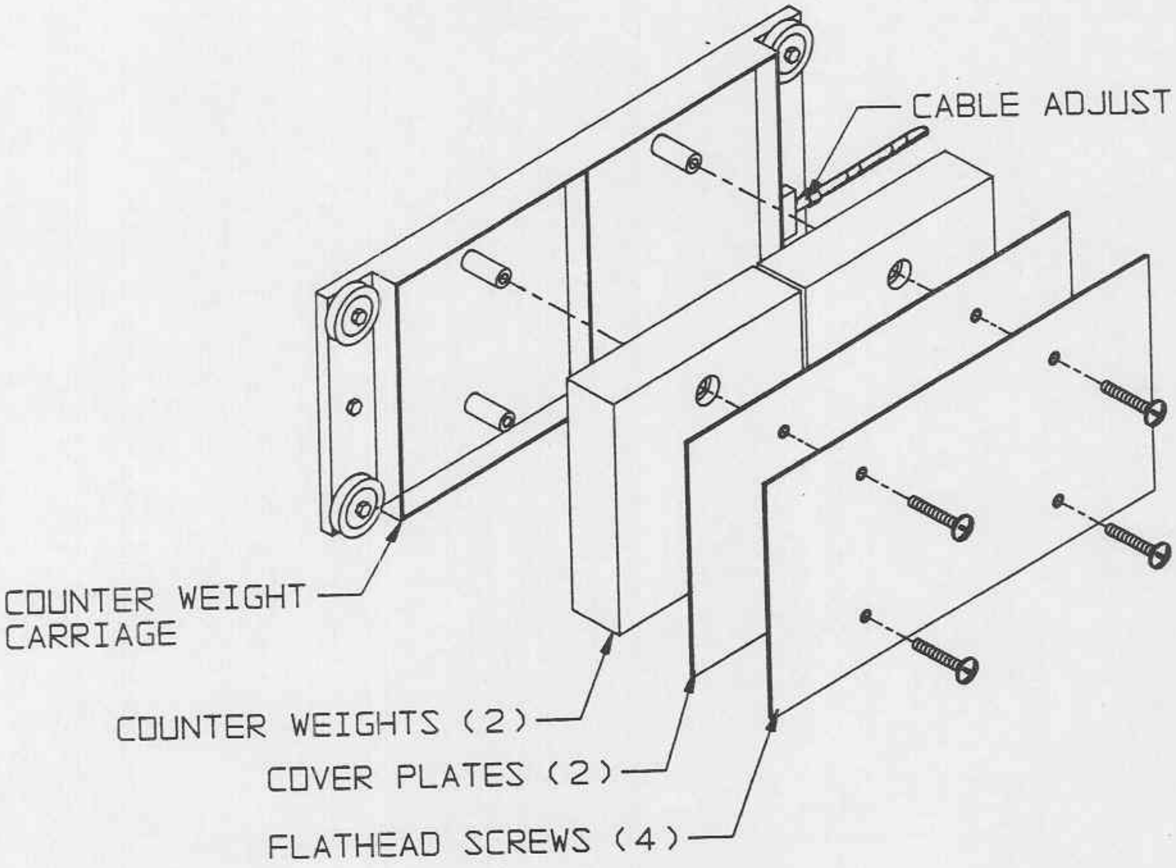
CABLE ADJUST
COUNTER WEIGHT CARRIAGE
COUNTER WEIGHTS (2)
COVER PLATES (2)
FLATHEAD SCREWS (4)

FIGURE 3-3 REAR COUNTERWEIGHTS

3.4 OPERATIONAL CHECK

The operational tests in this section are also needed to ensure patient safety and ease of operation.

When performing these tests, pay particular attention to smoothness and ease of operation.

Make sure that there is no difficulty of operation, squeaking or other unusual noises, or malfunction(s).

Exercise all table motions as follows (see **FIGURE 3-4** for switch locations):

1. Press and hold the Longitudinal Foot switch (B) until the table top reaches its limit of travel.

   It should move approximately 30", from it's centered position, before it stops.

2. Press and hold the Longitudinal Head switch (A) until the table top reaches its limit of travel.

   It should move approximately 30", from it's centered position, before it stops.

3. Press and hold the Table Center switch (C) until the until the table top stops.

   It should move to its center position, from either of the above mentioned longitudinal positions, before stopping.

4. Press and hold the Trendelenburg Tilt Switch (D) until the table reaches its maximum tilt.

   It should tilt 12° toward the head end (-12° Trendelenburg) and stop.

3.4 OPERATIONAL CHECK (continued)

5 . Press and hold the Vertical Tilt switch (E) until the table top reaches its maximum tilt.

The table should tilt 88° toward the foot end before it stops.

6. Engage all locks and attempt to reposition the spot film device in all directions; it should take a minimum of 20 pounds of force to move a corresponding part.

The locks should not make a "banging" sound when engaged.

WARNING:

A faulty lock can cause serious injury.

Do not use a system with malfunctioning locks.

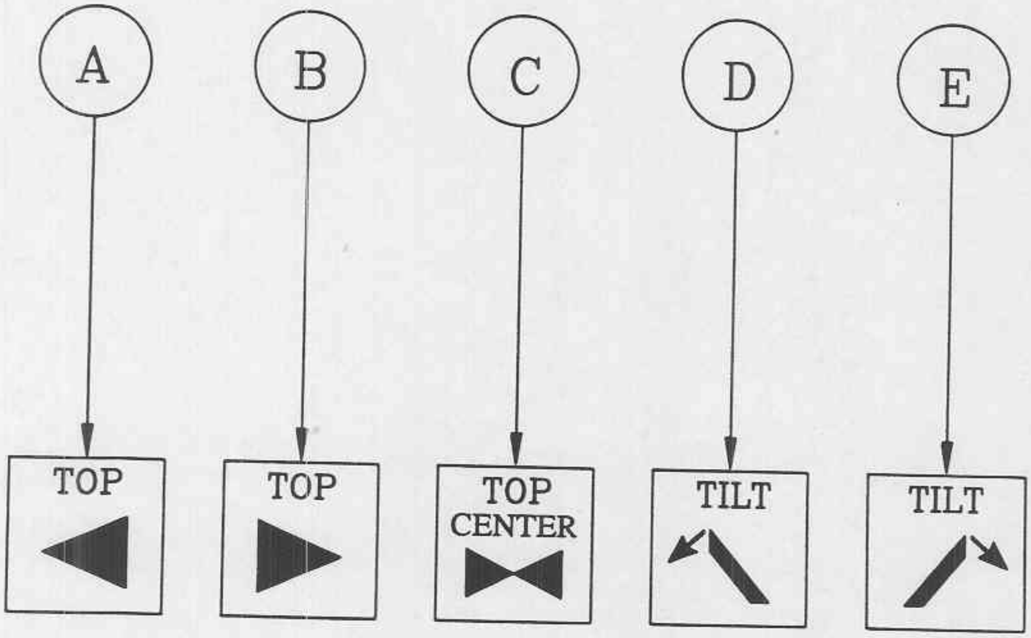
A
B
C
D
E
TOP
TOP
TOP
CENTER
TILT
TILT

FIGURE 3-4 TABLE SIDE CONTROLS

3.5 LOCK ADJUSTMENTS

TRANSVERSE AND COMPRESSION LOCK ADJUSTMENT

The transverse lock is located inside the table, while the compression lock is located in the table tower.

The compression lock can be accessed from the top and bottom of the tower without removing covers. For transverse lock, see **FIGURE 3-6**. For compression lock, see **FIGURE 3-1**.

1. If necessary, turn off the power and follow the procedure in **Section 3.9.1** to remove the table top.

2. The transverse and compression locks are held in adjustment on two threaded studs by means of nuts and lock washers.

   Adjustment consists of moving the lock in or out along the length of the studs by the nuts.

3. Engage the lock and attempt to move the corresponding part. It should take a minimum of 20 pounds of force to move. Locks should not make a "banging" sound when energized.

   If there is a "banging" sound, move the lock closer to the corresponding part by disengaging the lock and turning interior nuts approximately one-half turn clockwise. Do the same with the outer nuts.

   Repeat this procedure as many times as necessary until there is no longer a "banging" sound.

LONGITUDINAL AND GRID LOCK ADJUSTMENT

1. **If necessary, turn off the power and follow the procedure in Section 3.9.1 to remove the table top.**

3.5 LOCK ADJUSTMENTS (continued)

2. The longitudinal and grid locks are held in adjustment on two threaded studs by means of springs secured with washers and cotter pins.

Adjustment consists of moving the lock in or out, by tightening or loosening the studs with a hex key wrench.

3. Engage the lock and attempt to move the corresponding part. It should take a minimum of 20 pounds of force. Locks should not make a "banging" sound when energized.

If there is a "banging" sound, disengage the lock and move it closer to the corresponding part by turning hex socket studs clockwise approximately one-half turn.

Repeat as many times as necessary until there is no longer a "banging" sound.

3.6 TILT DRIVE CHAIN TENSION ADJUSTMENT (FIGURE 3-7)

1. If necessary, remove the drive mechanism cover at the foot end of the table body.

2. Use a torque wrench to apply 11 foot-pounds to the tension screw.

3. Replace all covers on the table.

3.7 CLEANING

WARNING:

Turn power off when cleaning near electrical wiring.

Spillage of any liquid on the table can cause a malfunction, particularly if it finds its way into the interior.

This is especially so with liquids that leave a solid residue after they dry. It is important to promptly remove spills with a soft cloth dampened in warm water.

Regular cleaning can also be accomplished with a soft cloth, warm water, and a mild detergent.

3.8 LUBRICATION

All bearings and bearing raceways should be lubricated every six months using a light grade of machine oil (like WD-40).

Check the oil level in the Tilt Drive and the Table Top Longitudinal Drive gear reducers annually. If the level is low, or if there is any sign of leaking, add a gear oil like Shell Valvata No. J-78.

3.9 CORRECTIVE MAINTENANCE

The information in this section assists maintenance personnel in the correction of malfunctions by providing instructions for gaining access to the table interior.

Some parts replacement procedures are also included.

Correcting malfunctions often makes it necessary to remove table parts or assemblies in order to gain access to the faulty component(s).

3.9.1 TABLE TOP REMOVAL AND REPLACEMENT (FIGURE 3-5)

1. Remove the three flat head phillips screws from the rear edge of the table top.

2. Push on the front edge of the top and lift it from the table.

3. To remove the subtop off the table, move the table top frame towards the end of the table with the most clearance to the wall.

4. Remove the bracket at the exposed end of the table that holds the subtop.

5. Loosen the screws that hold the brackets that hold the subtop at the front and the rear.

6. Move the table top frame to the other end of the table and repeat steps 4 and 5.

7. Slide the subtop off the table body. The sub-top is FRAGILE! Handle with care.

8. Replace the subtop by sliding it under the front and rear brackets (2 brackets at each end of the table) and replace the foot and head end brackets.

Tighten the screws holding the front and rear brackets.

9. Replace the table top by positioning it on the table top frame carriage and pushing on the rear edge while guiding it into place.

It will be necessary to adjust its longitudinal position in order to align the mounting holes in the table top and carriage.

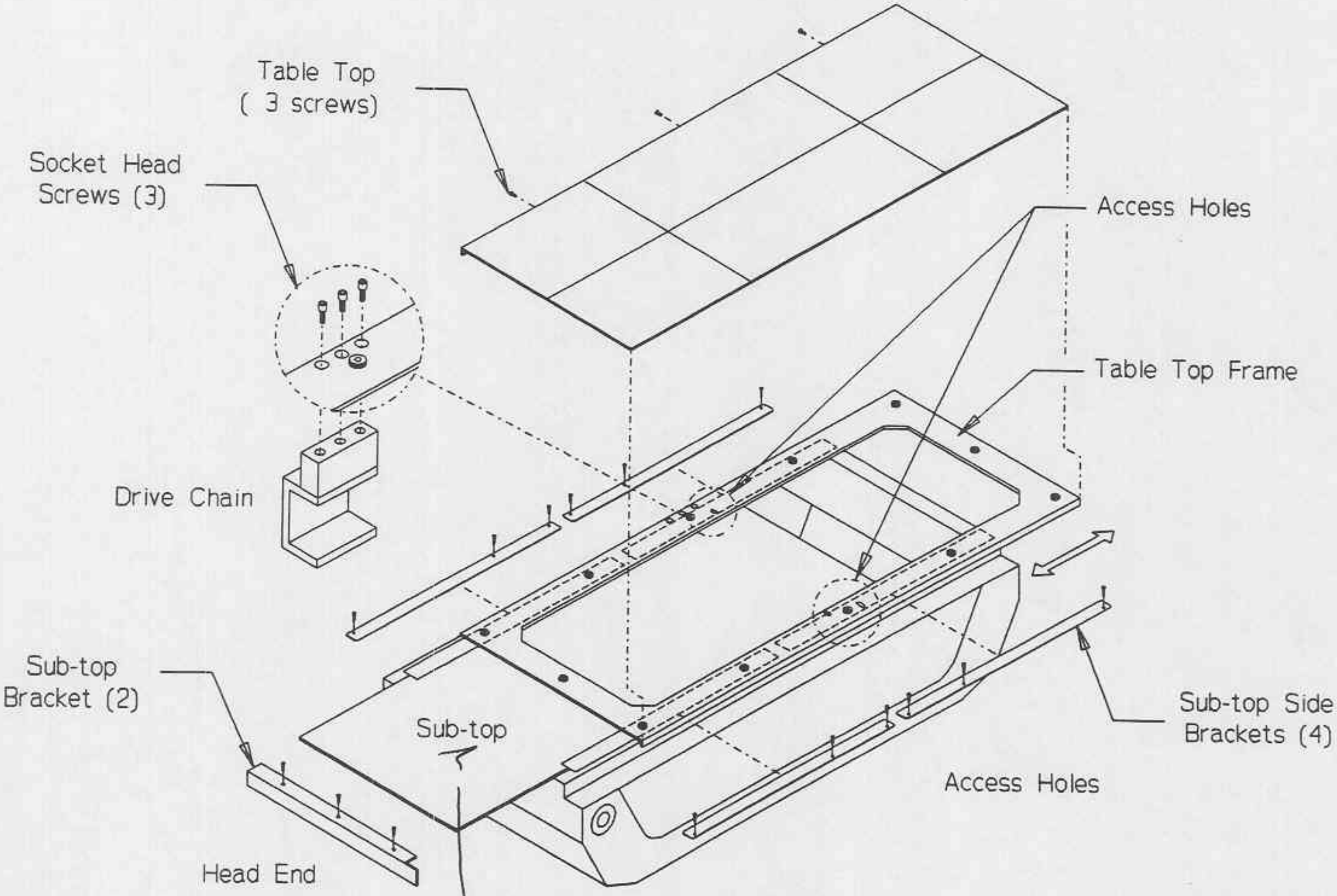
Table Top
(3 screws)
Socket Head
Screws (3)
Access Holes
Table Top Frame
Drive Chain
Sub-top
Bracket (2)
Sub-top
Sub-top Side
Brackets (4)
Access Holes
Head End

PN 6459.328.03
Barium Shield

FIGURE 3-5 TABLE TOP REMOVAL

3.9.2 CABLE REPLACEMENT

UPPER VERTICAL CARRIAGE CABLE REPLACEMENT

The tower vertical carriage is attached to the counterweight holder by means of three cables.

The two upper cables are attached to the upper corners of the counterweight holder.

To replace these cables:

1. Tilt the table to the vertical position.

2. Remove the rear cover from the tower.

Notice that each upper cable is routed up from the counterweight carriage equalizer bar, over a pulley and down beneath another pulley and up again, where it anchors in a block on the tower by a stop sleeve swaged onto its end.

Each cable is attached to the carriage equalizer by means of a swaged-in loop.

3. Remove the counterweights on the rear of the counterweight carriage (**FIGURE 3-1**).

4. Disengage the looped end of the cable from the groove at the end of the counterweight equalizer.

5. Disengage the stop sleeve end of the cable from its slotted block at the top of the tower and remove the cable.

6. Install the replacement cable by following the procedure in reverse.

Remember that two upper cables support the counterweight carriage, even if only one of them is being replaced.

3.9.2 CABLE REPLACEMENT (continued)

It is important to be sure that both cables are routed over their pulleys and the looped ends engage the grooves in their respective ends of the counterweight equalizer bar.

7. Replace rear cover on tower.

FRONT COUNTERWEIGHT CABLE REPLACEMENT (FIGURE 3-2)

1. The table should be in the horizontal position.

2. If the front counterweight cable needs to be replaced, remove table top and sub-top (refer to **Section 3.9.1**).

3. Loosen and remove cable adjustment, which is located at the foot end of the front counterweight.

4. Disconnect the cable from the carriage.

5. Install replacement cable and adjust tension with cable adjustment.

REAR COUNTERWEIGHT CABLE INSTALLATION (FIGURE 3-3)

1. The table should be in the horizontal position.

2. If the rear counterweight cable needs to be replaced, remove table top and sub-top (refer to **Section 3.9.1**).

3. There are two cables for the rear counterweights.

3.9.2 CABLE REPLACEMENT (continued)

4. Loosen and remove cable adjustment, which is located at the foot end of the rear counterweight.

5. Disconnect the appropriate cable from the carriage and the counterweight.

6. Install replacement cable and adjust tension with cable adjustment.

GRID CABINET COUNTERWEIGHT CABLE REPLACEMENT

1. The table should be in the horizontal position.

2. If the grid cabinet counterweight cable needs to be replaced, remove table top and sub-top (refer to **Section 3.9.1**).

3. Loosen cable adjustment, which is located at the foot end of the grid cabinet.

4. Disconnect the appropriate cable from the grid cabinet and counterweight.

NOTE:

It may be quicker to remove the appropriate counterweight pulley from the end of the table.

5. Install replacement cable and adjust tension with cable adjustment.

3.9.3. VERTICAL (COMPRESSION) LOCK REPLACEMENT

1. Turn off the power and follow the procedure in **Section 3.9.1** to remove the table top and subtop.

2. **FIGURE 3-1** shows the location of the compression lock. Label all wiring to this lock and disconnect it.

3. Remove compression lock by loosening securing nuts, and backing out the mounting screws.

4. Install the replacement lock, following the procedure in reverse.

5. Energize the table and engage the lock. Attempt to move the tower. It should take a minimum of 20 pounds of force to move the carriage.

Locks should not make a "banging" sound when energized. Adjust the compression lock, following the procedure in **Section 3.5**.

3.9.4 TRANSVERSE (FRONT-BACK) LOCK REPLACEMENT

1. Turn off the power and follow the procedure in **Section 3.9.1** to remove the table top and subtop.

2. **FIGURE 3-6** shows the location of the transverse lock. Label all wiring to this lock and disconnect it.

3. Remove the nuts that hold the lock on the two studs. **Do not disturb the nuts behind the lock mounting brackets.** Slide the lock off the studs.

4. Install the replacement lock, following this procedure in reverse.

5. Energize the table and engage the lock. Attempt to move the transverse carriage. It should take a minimum of 20 pounds of force to move the carriage.

Locks should not make a "banging" sound when energized. Adjust the transverse lock, following the procedure in **Section 3.5**.

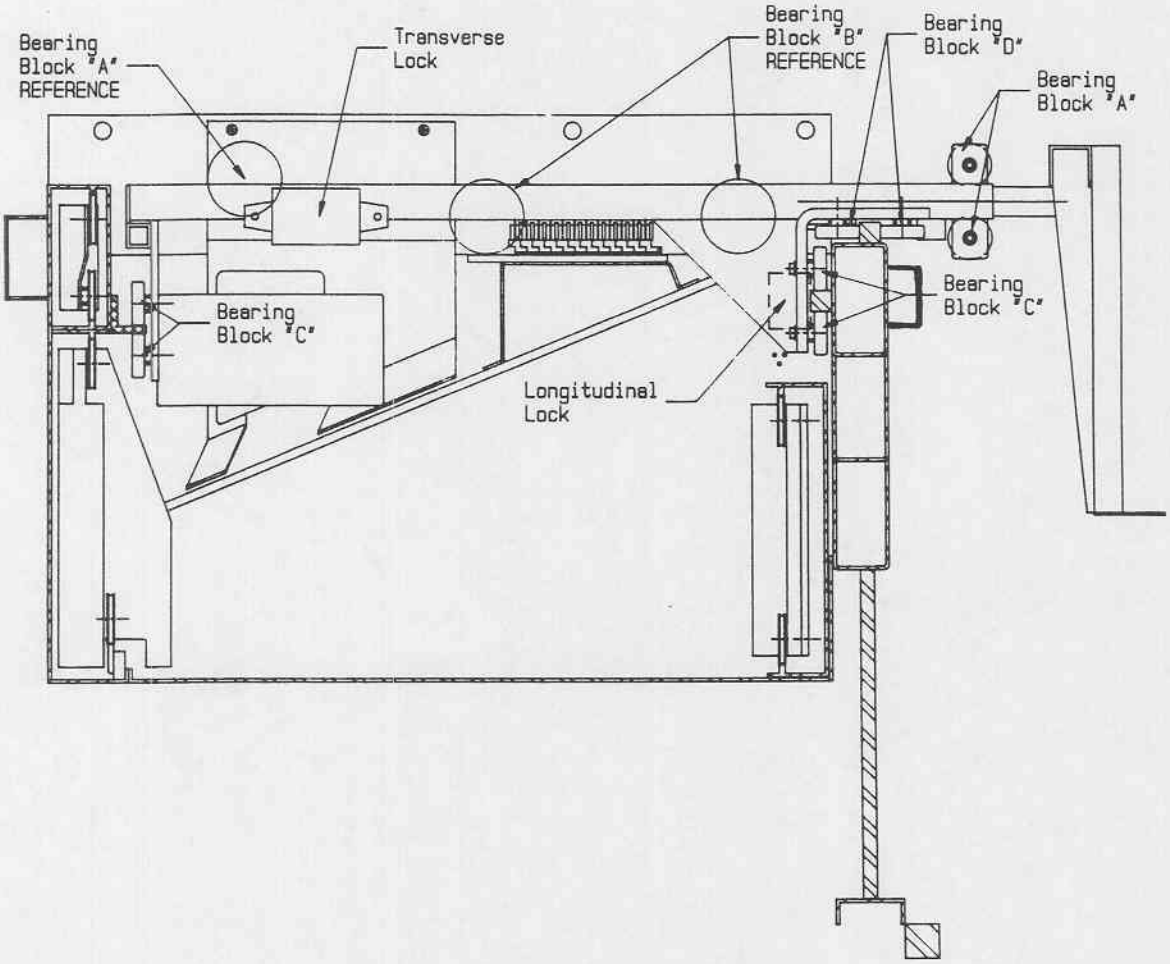
Bearing Block "A" REFERENCE
Transverse Lock
Bearing Block "B" REFERENCE
Bearing Block "D"
Bearing Block "A"
Bearing Block "C"
Bearing Block "C"
Longitudinal Lock

FIGURE 3-6 LONGITUDINAL AND LATERAL LOCKS

3.9.5 LONGITUDINAL (HEAD-FOOT) AND GRID LOCKS REPLACEMENT

1. Turn off the power and follow the procedure in **Section 3.9.1** to remove the table top.

2. Position the grid chamber at the foot end of the table and move the longitudinal carriage to the head end.

3. **FIGURE 3-6** shows the location of the longitudinal lock (the grid lock is located next to the grid).

Label all wiring on the lock and disconnect it.

4. Notice that the longitudinal (or grid) lock is suspended on two threaded, shouldered studs.

A spring, retained by a cotter pin and washer on each stud, holds the lock away from the carriage when it is disengaged.

5. Remove the cotter pin, washer, and spring from each stud.

It may be necessary to climb into the table body to perform this step.

An inspection mirror may be helpful when removing the hardware from the stud at the head end of the lock.

6. Use a hex key wrench to back out both studs until the lock can be removed.

7. Install the replacement lock by following the procedure in reverse.

8. Energize the table and engage the lock from the spot film device front panel.

Attempt to move the longitudinal carriage.

It should take a minimum of 20 pounds of force to move the carriage.

Locks should not make a "banging" sound when energized.

Adjust the longitudinal lock, following the procedure in **Section 3.5**.

3.9.6 TILT DRIVE CHAIN REPLACEMENT

1. **Turn off the power to the table and the remainder of the system.**

2. Wedge two lengths of heavy lumber between the bottom of the table body and the floor at the head end of the table.

3. Remove the drive mechanism cover at the foot end of the table leg (**FIGURE 3-7**).

4. Remove the protective cover over the gear reducer.

5. Loosen the chain tension and move the belt to the gear box for further slack on the head end.

6. Remove the two hex socket cap screws and hardware at each end of the chain. Remove the chain.

7. Use two of the screws and hardware that were removed in step 6 to attach the replacement chain to the chain guide at the foot end of the table.

8. Thread the chain around the gear box sprocket and idler to the head end anchor position. Secure in place with the hex socket cap screws.

9. Re-tension the chain (refer to **Section 3.6**).

10. Remove the wooden wedges.

11. Replace the covers.

3.10 ADJUST TILT CONTROL MERCURY SWITCHES

The table has four mercury switches to prevent table tilt when there is a danger of damage to the table. All four mercury switches are easily adjusted by twisting their position in a clamp until they make contact at the desired angle.

Two mercury switches are located at the foot-end of the table, attached at the rear of the Table Tilt PCB. Both of these switches protect the table top from damage. The switch farthest from the center of the table prevents table tilt from the horizontal to head-end up, when the table top is extended towards the head end.

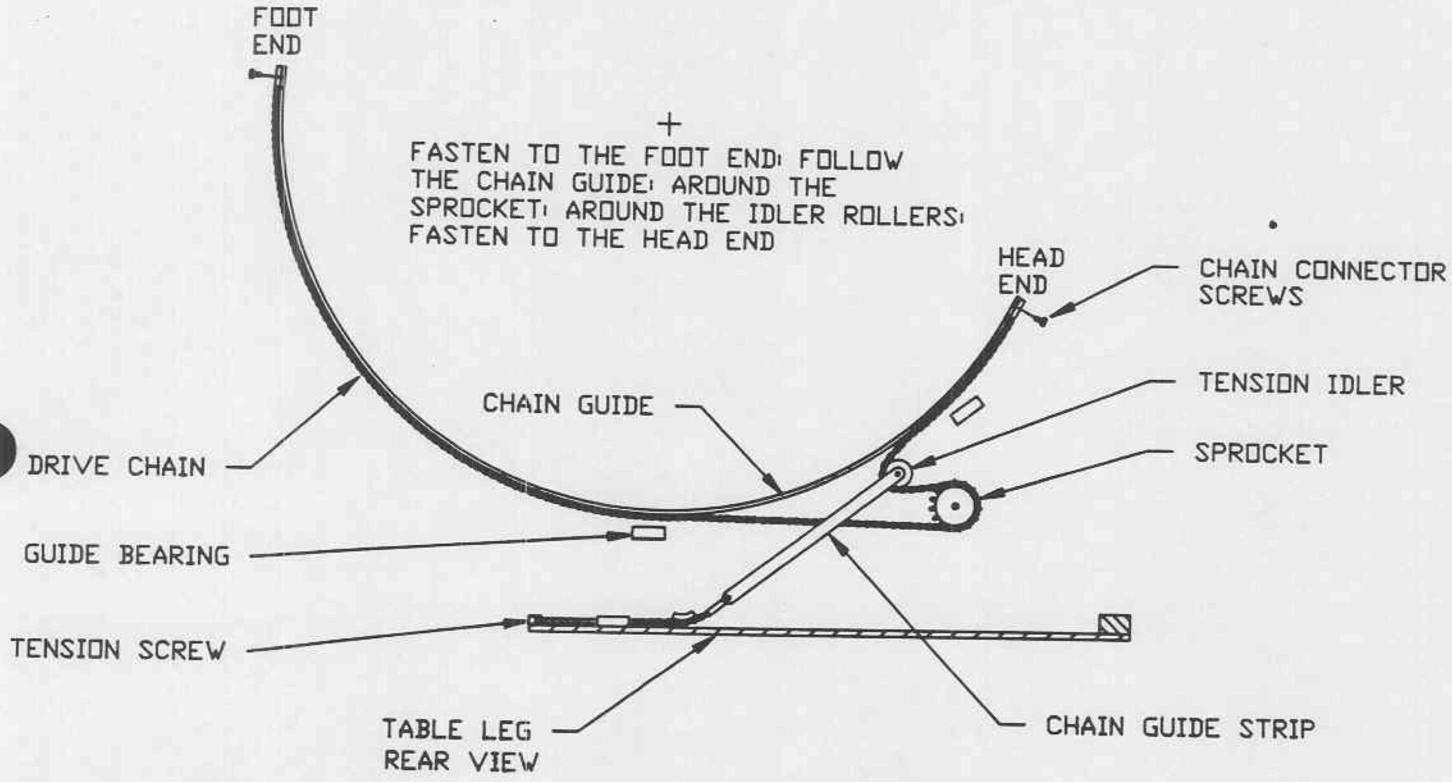
FOOT END
FASTEN TO THE FOOT END; FOLLOW THE CHAIN GUIDE; AROUND THE SPROCKET; AROUND THE IDLER ROLLERS; FASTEN TO THE HEAD END
HEAD END
CHAIN CONNECTOR SCREWS
TENSION IDLER
CHAIN GUIDE
SPROCKET
DRIVE CHAIN
GUIDE BEARING
TENSION SCREW
TABLE LEG REAR VIEW
CHAIN GUIDE STRIP

FIGURE 3-7 TABLE TILT DRIVE CHAIN

3.10 ADJUST TILT CONTROL MERCURY SWITCHES (continued)

This switch protects the table top from hitting the ceiling of the iso shelter when the top is extended toward the head end, and the table is tilted.

Adjust this switch to stop table tilt when the angle of 34° with the horizontal is reached, unless the table top is in the "Center" position.

The other switch attached to the Table Tilt PCB protects the table top from hitting the floor. The switch should stop the table from tilting when the table top is extended toward the foot end, and the table is tilted head end up.

Adjust this switch to stop table tilt when the angle of 20° with the horizontal is reached, unless the table top is either in the "Center" position, or extended toward the head end.

Inside the table body, at the head end, is a terminal strip for most of the table wiring. Attached to this terminal strip are two additional mercury switches.

Both of these switches protect the image intensifier system from hitting the ceiling during table tilt.

Both switches work in conjunction with the microswitch on the inside bottom of the table body, that is activated by the rear counterweight as it moves from head-end to foot-end, to counter-balance the spot film device. Therefore, it indirectly represents the longitudinal position of the spot film device and image intensifier.

The switch closest to the front of the table prevents tilt when the table is vertical, and tilt head-end down is activated, unless the spot film device carriage is in the center of the table. This switch should be set to allow tilt down to 78° when the spot device is near the head end of the table.

The switch towards the rear of the table prevents tilt when the table is horizontal, and tilt head-end up is activated, unless the spot film device carriage is in the center of the table or near the foot-end of the table.

If the above procedures are followed and "tilt" is not correctly prevented, check the microswitch sensor on the rear counterweight. The microswitch must be positioned so that it will activate when the rear counterweight passes it. Reposition with a screw driver, if necessary.

If the microswitch does not work, replace it with part # 4181.062.01, SW-V3L-121-D8 1.285 Arm Microswitch. Replace any of the four mercury switches with part # 4181.216.03, 5 Amp 115 Volt SPST Mercury Switch.

3.11 TABLE TOP CAM SWITCH ADJUSTMENT

The table longitudinal drive cam switches are set at the factory and should not need adjustments in the field. If adjustment is necessary, follow the procedures in this section.

During operation, table top movement should meet the following specifications:

1. The table top can be positioned to a maximum of 30" past the head end of the table body.

2. The table top can be positioned to a maximum of 30" past the foot end of the table body.

3. The table top returns to center position from either the head or foot end using the center momentary switch located on the front skirt of the table.

4. With table vertical: the table top should move to either the head or foot end of the table no more than 1".

3.11.1 TABLE TOP MOVEMENT LEFT LIMIT ADJUSTMENT

1. Verify that adjustment is necessary.

    a. Place a piece of tape on the table top frame 30" from the left (head) end. Mark exactly the 30" position for reference.

    b. Press [**TOP** ◂] until the table top stops. If the table top stops when the reference mark at 30" is aligned with the head end of the table body, no adjustment is necessary.

WARNING:

Under no circumstances is any adjustment to be performed while the table top is being driven. Serious injury could result.

Adjustments to cam orientation are to be made first, and then alternated with verification through actuating the table top drive system.

2. Remove the table top and the table sub-top. Reference **Section 3.9.1.**

3. Locate the top drive control switch assembly (5536.009.06), mounted to the table bearing top inner frame assembly. Reference **FIGURE 4-16**

3.11.1 TABLE TOP MOVEMENT LEFT LIMIT ADJUSTMENT (continued)

4. Locate cam 1 on the top drive control switch assembly (reference **FIGURE 4-17**). Cam 1 is closest to the gear reducer (6468.062.01).

5. Using a 1/4" wrench, slightly loosen the screw securing the position of cam 1.

WARNING:

Damage to the table can result if over-adjustment is done. Small, incremental adjustments alternated with verification must be done to ensure safe operation.

6. Rotate cam 1 a small amount in either direction and secure the locking screw.

7. Press [**TOP ▸**] to move the table top back toward center.

8. Press [**TOP ◂**] and observe the table top new stop position in relation to the mark.

9. If the mark lines up with the table body end, adjustment is complete.

10. Further incremental adjustment is dependant upon the new stop position.

    a. If the table traveled further out of alignment, cam 1 must be rotated a small amount in the opposite direction. Go to step 6 and proceed.

    b. If the table traveled closer to proper alignment, cam 1 is being rotated in the correct direction. Go to step 6 and proceed.

11. Upon completion of adjustment replace the table sub-top and the table top. Reference **Section 3.9.1**.

3.11.2 TABLE TOP MOVEMENT RIGHT LIMIT ADJUSTMENT

1. Verify that adjustment is necessary.

    a. Place a piece of tape on the table top frame 30" from the right (foot) end. Mark exactly the 30" position for reference.

    b. Press [**TOP ▸**] until the table top stops. If the table top stops when the reference mark at 30" is aligned with the foot end of the table body, no adjustment is necessary.

3.11.2 TABLE TOP MOVEMENT RIGHT LIMIT ADJUSTMENT (continued)

WARNING:

Under no circumstances is any adjustment to be performed while the table top is being driven. Serious injury could result.

Adjustments to cam orientation are to be made first, and then alternated with verification through actuating the table top drive system.

2. Remove the table top and the table sub-top. Reference **Section 3.9.1.**

3. Locate the top drive control switch assembly (5536.009.06), mounted to the table bearing top inner frame assembly. Reference **FIGURE 4-16**

4. Locate cam 4 on the top drive control switch assembly (reference **FIGURE 4-17**). Cam 4 is the fourth cam from the gear reducer (6468.062.01).

5. Using a 1/4" wrench, slightly loosen the screw securing the position of cam 4.

WARNING:

Damage to the table can result if over-adjustment is done. Small, incremental adjustments alternated with verification must be done to ensure safe operation.

6. Rotate cam 4 a small amount in either direction and secure the locking screw.

7. Press **[TOP ◂]** to move the table top back toward center.

8. Press **[TOP ▸]** and observe the table top new stop position in relation to the mark.

9. If the mark lines up with the table body end, adjustment is complete.

10. Further incremental adjustment is dependant upon the new stop position.

    a. If the table traveled further out of alignment, cam 4 must be rotated a small amount in the opposite direction. Go to step 6 and proceed.

    b. If the table traveled closer to proper alignment, cam 4 is being rotated in the correct direction. Go to step 6 and proceed.

3.11.2 TABLE TOP MOVEMENT RIGHT LIMIT ADJUSTMENT (continued)

11. Upon completion of adjustment replace the table sub-top and the table top. Reference **Section 3.9.1.**

3.11.3 TABLE TOP LEFT OF CENTER POSITION ADJUSTMENT

1. Verify that adjustment is necessary.

   a. Press [**TOP CENTER ▸◂**] and observe that the table top centers itself by checking that the ends of the table top frame align with the ends of the table body. If the ends are in alignment, no adjustment is necessary.

   b. If the table top centers too far to the left end of the table body, proceed to step 2.

   c. If the table top centers too far to the right end of the table body, proceed to **Section 3.11.4.**

WARNING:

Under no circumstances is any adjustment to be performed while the table top is being driven. Serious injury could result.

Adjustments to cam orientation are to be made first, and then alternated with verification through actuating the table top drive system.

2. Remove the table top and the table sub-top. Reference **Section 3.9.1.**

3. Locate the top drive control switch assembly (5536.009.06), mounted to the table bearing top inner frame assembly. Reference **FIGURE 4-16**

4. Locate cam 2 on the top drive control switch assembly (reference **FIGURE 4-17**). Cam 2 is the second cam from the gear reducer (6468.062.01).

5. Using a 1/4" wrench, slightly loosen the screw securing the position of cam 2.

WARNING:

Damage to the table can result if over-adjustment is done. Small, incremental adjustments alternated with verification must be done to ensure safe operation.

3.11.3 TABLE TOP LEFT OF CENTER POSITION ADJUSTMENT (continued)

6. Rotate cam 2 a small amount in either direction and secure the locking screw.

7. Press [**TOP** ◂] to move the table top to the left any amount.

8. Press [**TOP** ▸◂] to center the table top.

9. If the table top ends align with the table body ends, adjustment is complete.

10. Further incremental adjustment is dependant upon the new stop position.

    a. If the table traveled further out of alignment, cam 2 must be rotated a small amount in the opposite direction. Go to step 6 and proceed.

    b. If the table traveled closer to proper alignment, cam 2 is being rotated in the correct direction. Go to step 6 and proceed.

11. Upon completion of adjustment replace the table sub-top and the table top. Reference **Section 3.9.1.**

3.11.4 TABLE TOP RIGHT OF CENTER POSITION ADJUSTMENT

1. Verify that adjustment is necessary.

    a. Press [**TOP CENTER** ▸◂] and observe that the table top centers itself by checking that the ends of the table top frame align with the ends of the table body. If the ends are in alignment, no adjustment is necessary.

    b. If the table top centers too far to the left (head) end of the table body, proceed to **Section 3.11.3.**

    c. If the table top centers too far to the right (foot) end of the table body, proceed to step 2.

WARNING:

Under no circumstances is any adjustment to be performed while the table top is being driven. Serious injury could result.

Adjustments to cam orientation are to be made first, and then alternated with verification through actuating the table top drive system.

3.11.4. TABLE TOP RIGHT OF CENTER POSITION ADJUSTMENT (continued)

2. Remove the table top and the table sub-top. Reference **Section 3.9.1.**

3. Locate the top drive control switch assembly (5536.009.06), mounted to the table bearing top inner frame assembly. Reference **FIGURE 4-16**

4. Locate cam 3 on the top drive control switch assembly (reference **FIGURE 4-17**). Cam 3 is the third cam from the gear reducer (6468.062.01).

5. Using a 1/4" wrench, slightly loosen the screw securing the position of cam 3.

WARNING:

Damage to the table can result if over-adjustment is done. Small, incremental adjustments alternated with verification must be done to ensure safe operation.

6. Rotate cam 3 a small amount in either direction and secure the locking screw.

7. Press [**TOP** ▸] to move the table top to the right any amount.

8. Press [**TOP** ▸ ◂] to center the table top.

9. If the table top ends align with the table body ends, adjustment is complete.

10. Further incremental adjustment is dependant upon the new stop position.

    a. If the table traveled further out of alignment, cam 3 must be rotated a small amount in the opposite direction. Go to step 6 and repeat the procedure.

    b. If the table traveled closer to proper alignment, cam 3 is being rotated in the correct direction. Go to step 6 and repeat.

11. Upon completion of adjustment, replace the table sub-top and the table top. Reference **Section 3.9.1.**

3.11.5 TABLE TOP "0 INCH" POSITION (VERTICAL MODE) ADJUSTMENT

The "0 inch" position cam ensures that the table will not move more than 1 inch when the table is in a vertical position.

1. Verify that adjustment is necessary.

    a. Apply a piece of tape to each end of the table top frame to cover an area one inch from the end. Measure one inch from the end and mark this. Do this for each end.

    b. Press [**TOP CENTER** ▸◂] to center the table top. If the table top does not center itself, follow the procedure in **Section 3.11.3**. If it does proceed.

    c. Raise the head end until the table is a full 90° (vertical).

    d. Press [**TOP** ◂] and observe that the table top stops before the reference mark at the left (head) end of the table top frame is aligned with the table body end.

    If it is out of alignment, proceed to step 2.

    e. Press [**TOP** ▸] and observe that the table top stops before the reference mark at the right (foot) end of the table top frame is aligned with the table body end.

    If it is out of alignment, proceed to step 2. If alignment is correct, no adjustment necessary.

WARNING:

Under no circumstances is any adjustment to be performed while the table top is being driven. Serious injury could result.

Adjustments to cam orientation are to be made first, and then alternated with verification through actuating the table top drive system.

2. Lower the head end until the table is 0° (horizontal). Remove the table top and the table sub-top. Reference **Section 3.9.1**.

3. Raise the head end until the table is a full 90° (vertical).

3.11.5 TABLE TOP "0 INCH" POSITION (VERT. MODE) ADJUSTMENT (continued)

4. Press [**TOP CENTER** ▸◂] to center the table top.

5. Locate the top drive control switch assembly (5536.009.06), mounted to the table bearing top inner frame assembly. Reference **FIGURE 4-16**

6. Locate cam 6 on the top drive control switch assembly (reference **FIGURE 4-17**). Cam 6 is the sixth cam from the gear reducer (6468.062.01).

7. Using a 1/4" wrench, slightly loosen the screw securing the position of cam 6.

WARNING:

Damage to the table and the iso shelter can result if over-adjustment is done. Small, incremental adjustments alternated with verification must be done to ensure safe operation.

8. Rotate cam 6 a small amount in either direction and secure the locking screw.

9. Verify that both ends of the table top stop before the reference marks align with the respective ends of the table body.

    a. Press [**TOP** ◂] to move the table top to the left (up) and observe that the table top stops before the reference mark on the table top frame aligns with the table body.

    If alignment is not correct, proceed to step 10.

    b. Press [**TOP** ▸] to move the table top to the right (down) and observe that the table top stops before the reference mark on the table top frame aligns with the table body.

    If alignment is correct, adjustment is complete. Proceed to step 11.

10. Further incremental adjustment is dependant upon the new stop position. Any change in one direction affects the other an opposite and equal amount.

    a. If the table traveled further out of alignment, cam 6 must be rotated a small amount in the opposite direction. Go to step 7 and repeat.

3.11.5 TABLE TOP "0 INCH" POSITION (VERT. MODE) ADJUSTMENT (continued)

b. If the table traveled closer to proper alignment, cam **6** is being rotated in the correct direction. Go to step 7 and repeat.

11. Upon completion of adjustment, press [**TOP CENTER** ►◄] to center the table top and lower the head end until the table is 0° (horizontal).

12. Replace the table sub-top and the table top. Reference **Section 3.9.1.**

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SECTION 4 - ASSEMBLY DRAWINGS, PARTS LISTS, WIRING DIAGRAMS, AND SCHEMATICS

This section contains the assembly drawings, parts lists, wiring diagrams, and schematics for the MXT-90/15 table.

NOTES

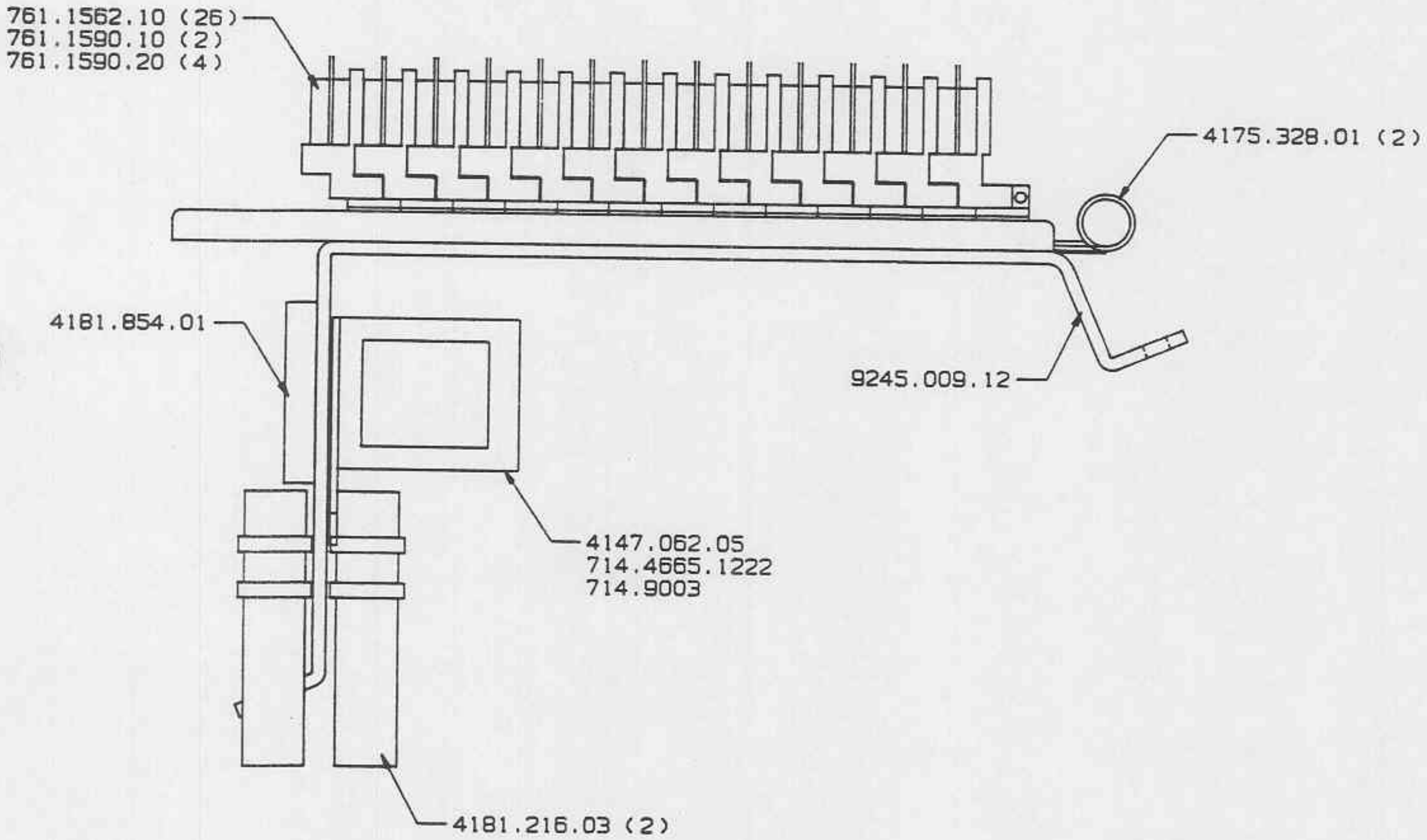

761.1562.10 (26)
761.1590.10 (2)
761.1590.20 (4)
4175.328.01 (2)
4181.854.01
9245.009.12
4147.062.05
714.4665.1222
714.9003
4181.216.03 (2)

FIGURE 4-2 TABLE HEAD END TERMINAL ASSEMBLY

	Part Number	Description	Quantity	
1.	121.1032.1257	10-32 X 3/4 Pan Steel Philips Screw	1	EA
2.	122.1032.22	10-32 Double Chamfered Hex Nut Stl	1	EA
3.	123.6100.20	#10 Internal Tooth Steel Lockwashr	1	EA
4.	4147.062.05	Mercury Sw & Relay Mntng Bracket	1	EA
5.	4175.328.01	1/2 Inch Cable Clamp	2	EA
6.	4179.062.22	MXT 90/15 Tbl Tilt Installation Tag	1	EA
7.	4181.216.03	5 Amp 115 Volt SPST Mercury Switch	2	EA
8.	4181.854.01	Table Tilt Monitor Switch Assembly	1	EA
9.	714.4665.1222	4PDT 24 Volt DC Mini Power Relay	1	EA
10.	714.9003.	4PDT Minirelay Solder Terminals	1	EA
11.	761.1562.10	4-Way Medium Duty Terminal Block	26	EA
12.	761.1590.10	Medium Terminal Block End	2	EA
13.	761.1590.20	Channel Mounting Clamp	4	EA
14.	762.8521.0182	1/4" #18 Female Loose Tab Terminal	74	EA
15.	771.1750.1350	500 Mfd 50 Volt Elctyc Capacitor	1	EA
16.	9245.009.12	Ainsworth Head Terminal Bracket	1	EA

TABLE 4-1 PARTS LIST FOR 5282.062.01 TABLE HEAD END TERMINAL ASM

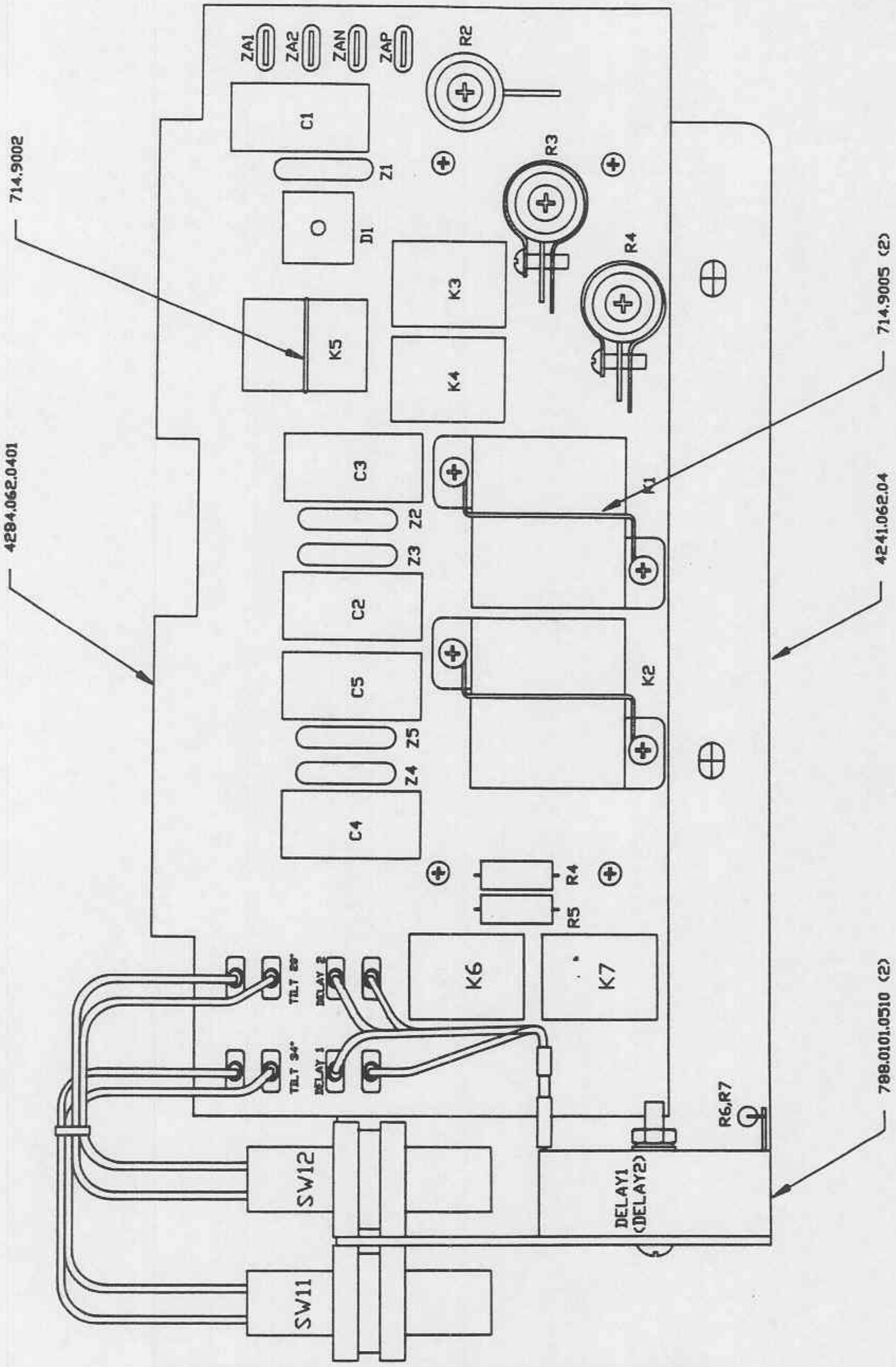
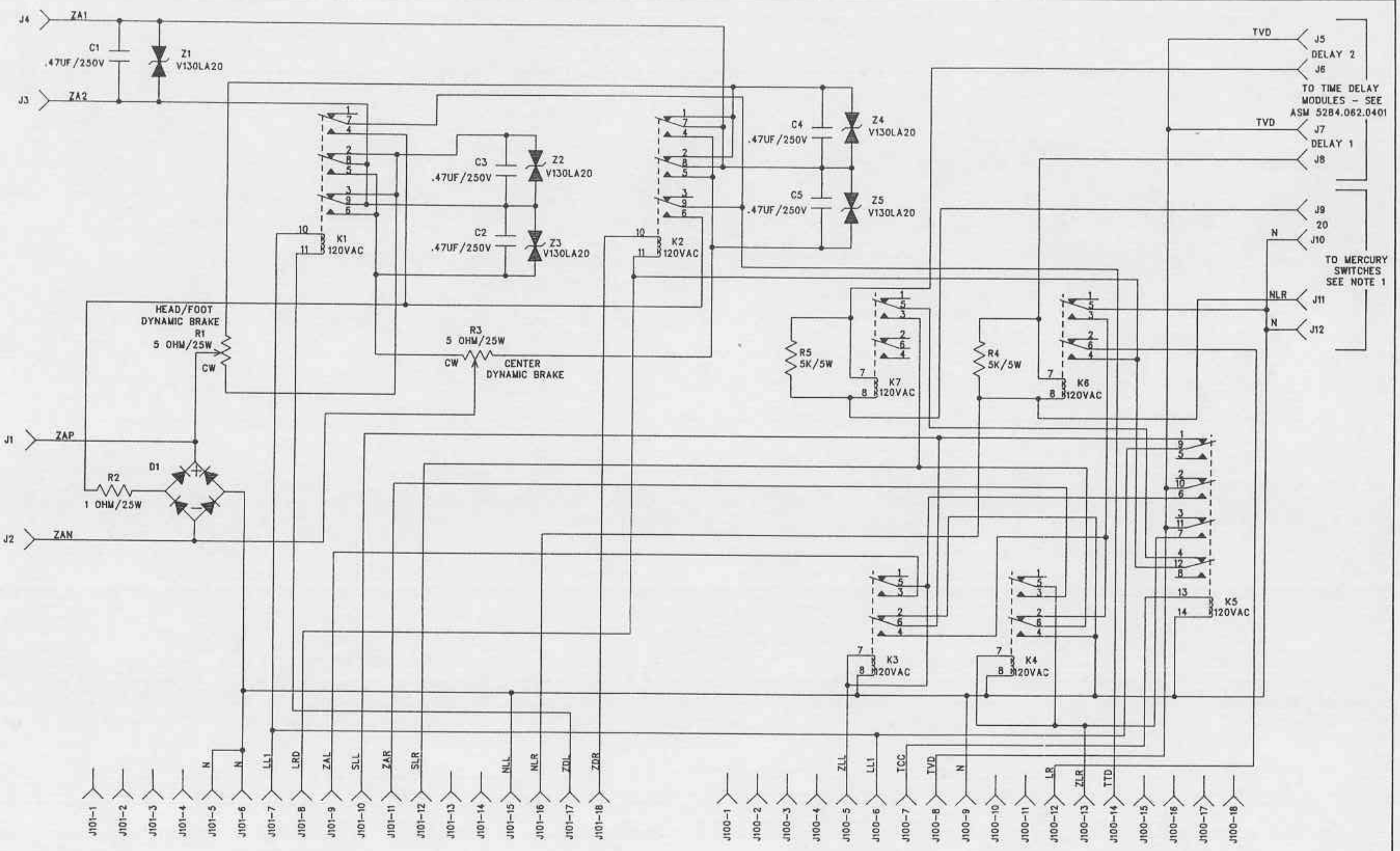

ZA1
ZA2
ZAN
ZAP
R2
C1
Z1
R3
D1
R4
K3
K5
K4
714.9002
714.9005 (2)
C3
K1
Z2
Z3
C2
C5
K2
Z5
Z4
C4
4284.062.0401
4241.062.04
R4
R5
K6
K7
TILT 28°
DELAY 2
TILT 34°
DELAY 1
R6,R7
788.0101.0510 (2)
SW12
DELAY1
(DELAY2)
SW11

FIGURE 4-3 LAYOUT FOR 5284.062.0401
MXT 90/15 POWER TOP LONGITUDINAL DRIVE PCB

	Part Number	Description	Quantity
1.	121.0632.0817	6-32 X 1/2 Round Steel Philps Screw	1 EA
2.	121.0832.4017	8-32 X 2-1/2 Round Steel Phlp Screw	2 EA
3.	122.0632.22	6-32 Double Chamfered Hex Steel Nut	1 EA
4.	123.2208.11	.171 ID .500 OD .070Thk.Brass Wash.	2 EA
5.	123.6060.20	#6 Internal Tooth Steel Lockwasher	2 EA
6.	129.5120.6511	1/8 X 3/16 Brass Eyelet	2 EA
7.	135.5401.	GE SR900 Silicone Conformal Coating	.01 GL
8.	4118.122.02	8-32 X 7/16 Fh A Rivnut	2 EA
9.	4141.060.18	Top Drive Mercury Switch Mtg Brckt	1 EA
10.	4153.222.04	Slide Band & Knob Asm, 25W, 50W Res	1 EA
11.	4175.328.01	1/2 Inch Cable Clamp	2 EA
12.	4181.216.03	5 Amp 115 Volt SPST Mercury Switch	2 EA
13.	4182.011.03	.250 X .032 T PCB Disconnect Tab	4 EA
14.	4284.062.04	MXT 90/15 Power Top Drive PC Blank	1 EA
15.	714.2271.23	DPDT 120 VAC Control Relay	2 EA
16.	714.3371.15	3PDT 10 Amp 11 Contct Plug-in Relay	2 EA
17.	714.4371.1221	4PDT 120 Volt AC Mini Relay	1 EA
18.	714.9001.	4PDT Mini Relay PC Socket	1 EA
19.	714.9002.	Relay Hold-Down Spring	1 EA
20.	714.9004.	11 Contact PC Socket	2 EA
21.	752.3256.21	1R 25W 5% Fixed WW Low T/C Resistor	1 EA
22.	753.3251.25	5.00 R 25 W WW Adj Low T/C Resistor	1 EA
23.	771.1612.1425	12 Mfd 250 Volt Elcytc Capacitor	2 EA
24.	781.3605.6008	6A 600 PIV Silicon Bridge Rectifier	1 EA

TABLE 4-2 PARTS LIST FOR 5284.062.0401 POWER TOP LONG. DRIVE PANEL ASM


J4
ZA1
C1
.47UF/250V
Z1
V130LA20
J3
ZA2
C3
.47UF/250V
Z2
V130LA20
C2
.47UF/250V
Z3
V130LA20
C4
.47UF/250V
Z4
V130LA20
C5
.47UF/250V
Z5
V130LA20
K1
120VAC
K2
120VAC
HEAD/FOOT
DYNAMIC BRAKE
R1
5 OHM/25W
CW
R3
5 OHM/25W
CW
CENTER
DYNAMIC BRAKE
J1
ZAP
D1
R2
1 OHM/25W
J2
ZAN
TVD
J5
DELAY 2
J6
TO TIME DELAY
MODULES - SEE
ASM 5284.062.0401
TVD
J7
DELAY 1
J8
J9
20
N
J10
TO MERCURY
SWITCHES
SEE NOTE 1
NLR
J11
N
J12
R5
5K/5W
K7
120VAC
R4
5K/5W
K6
120VAC
K5
120VAC
K3
120VAC
K4
120VAC
N
N
LL1
LRD
ZAL
SLL
ZAR
SLR
NLL
NLR
ZDL
ZDR
ZLL
LL1
TCC
TVD
N
LR
ZLR
TTD
J101-1
J101-2
J101-3
J101-4
J101-5
J101-6
J101-7
J101-8
J101-9
J101-10
J101-11
J101-12
J101-13
J101-14
J101-15
J101-16
J101-17
J101-18
J100-1
J100-2
J100-3
J100-4
J100-5
J100-6
J100-7
J100-8
J100-9
J100-10
J100-11
J100-12
J100-13
J100-14
J100-15
J100-16
J100-17
J100-18

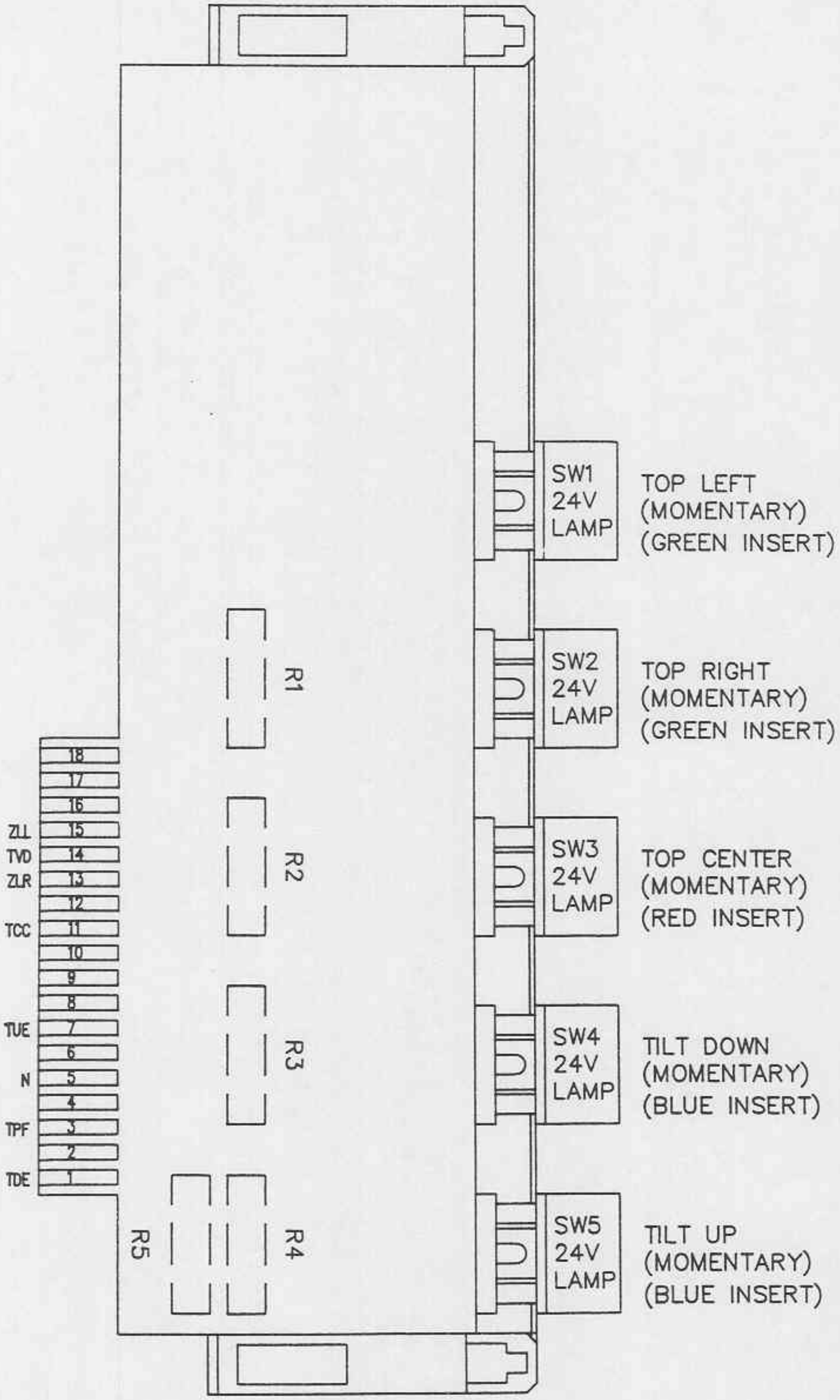
MXT 90/15 POWER TOP LONG DRIVE

FIGURE 4-4 SCHEMATIC FOR 5284.062.0401
MXT 90/15 POWER TOP LONGITUDINAL DRIVE PCB

NOTE 1: J9 AND J10 CONNECT TO MERCURY SWITCH SW12 ON ASSEMBLY 5284.062.0401 WHICH OPENS WHEN TABLE TILTS 20 ° TO RIGHT

J11 AND J12 CONNECT TO MERCURY SWITCH SW11 ON ASSEMBLY 5284.062.0401 WHICH OPENS WHEN TABLE TILTS 34 ° TO RIGHT

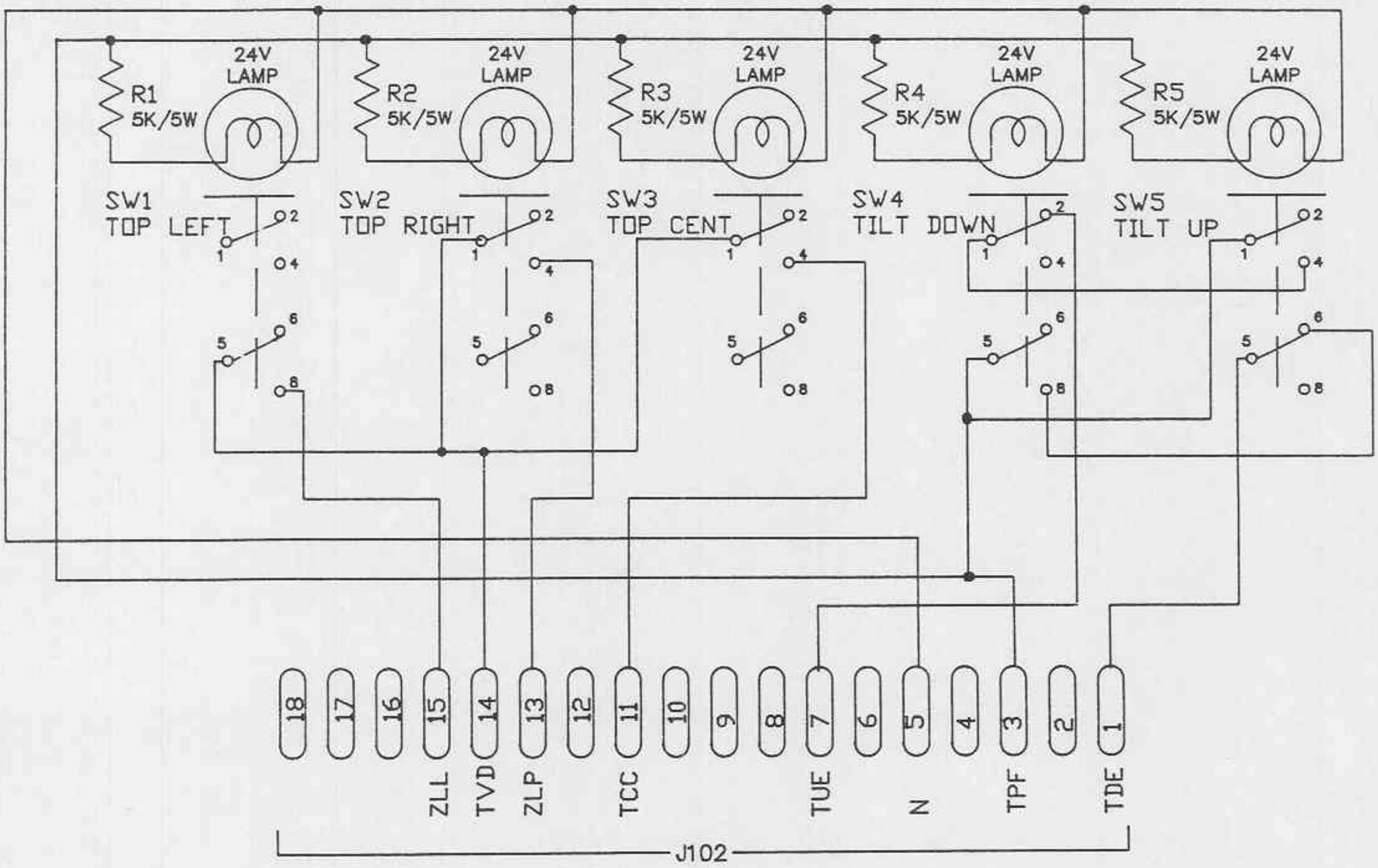
NOTE 2: FOR ASSEMBLY DRAWING SEE 5284.062.0401


SW1
24V
LAMP
TOP LEFT
(MOMENTARY)
(GREEN INSERT)
SW2
24V
LAMP
TOP RIGHT
(MOMENTARY)
(GREEN INSERT)
SW3
24V
LAMP
TOP CENTER
(MOMENTARY)
(RED INSERT)
SW4
24V
LAMP
TILT DOWN
(MOMENTARY)
(BLUE INSERT)
SW5
24V
LAMP
TILT UP
(MOMENTARY)
(BLUE INSERT)
R1
R2
R3
R4
R5
18
17
16
ZLL 15
TVD 14
ZLR 13
12
TCC 11
10
9
8
TUE 7
6
N 5
4
TPF 3
2
TDE 1

MXT 90/15 TABLE 5 FUNCTION CONTROL SWITCH
FIGURE 4-5 LAYOUT FOR 5284.062.1801

	Part Number	Description	Quantity
1.	135.5401.	GE SR900 Silicone Conformal Coating	.01 GL
2.	4140.011.04	Ledex Mounting Block 1/8 Hole Plate	2 EA
3.	4284.062.1801	MXT 90/15 5 Function Switch PC Blnk	1 EA
4.	717.0111.30	Ledex Switch Module PC Terminal	5 EA
5.	717.0113.12	3/4 Square PB Switch Light Shield	5 EA
6.	717.0113.13	3/4" Square PB Switch Clear Outcap	5 EA
7.	717.0113.1420	Red Ledex Lens Cap Insert	1 EA
8.	717.0113.1450	Green Ledex Lens Cap Insert	2 EA
9.	717.0113.1460	Blue Ledex Lens Cap Insert	2 EA
10.	717.0113.1491	White Ledex Lens Cap Insert	5 EA
11.	717.0113.3210	24 Volt 20 mA Slide Base Bulb	5 EA
12.	717.0114.10	Ledex Switch Mounting Block	2 EA
13.	717.0114.50	Hex Head Module Mounting Screw	28 EA
14.	717.0115.11	10 Segment Ledex Mounting Channel	1 EA
15.	752.2506.55	5K 5W 5% Fixed WW Low T/C Resistor	5 EA

TABLE 4-3 PARTS LIST FOR 5284.062.1801 5 FUNCTION CONTROL SWITCH


R1 5K/5W
24V LAMP
R2 5K/5W
24V LAMP
R3 5K/5W
24V LAMP
R4 5K/5W
24V LAMP
R5 5K/5W
24V LAMP
SW1 TOP LEFT
SW2 TOP RIGHT
SW3 TOP CENT
SW4 TILT DOWN
SW5 TILT UP
1
2
4
5
6
8
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
ZLL
TVD
ZLP
TCC
TUE
N
TPF
TDE
J102

MXT 90/15 TABLE 5 FUNCTION CONTROL SWITCH
FIGURE 4-6 SCHEMATIC FOR 5284.062.1801

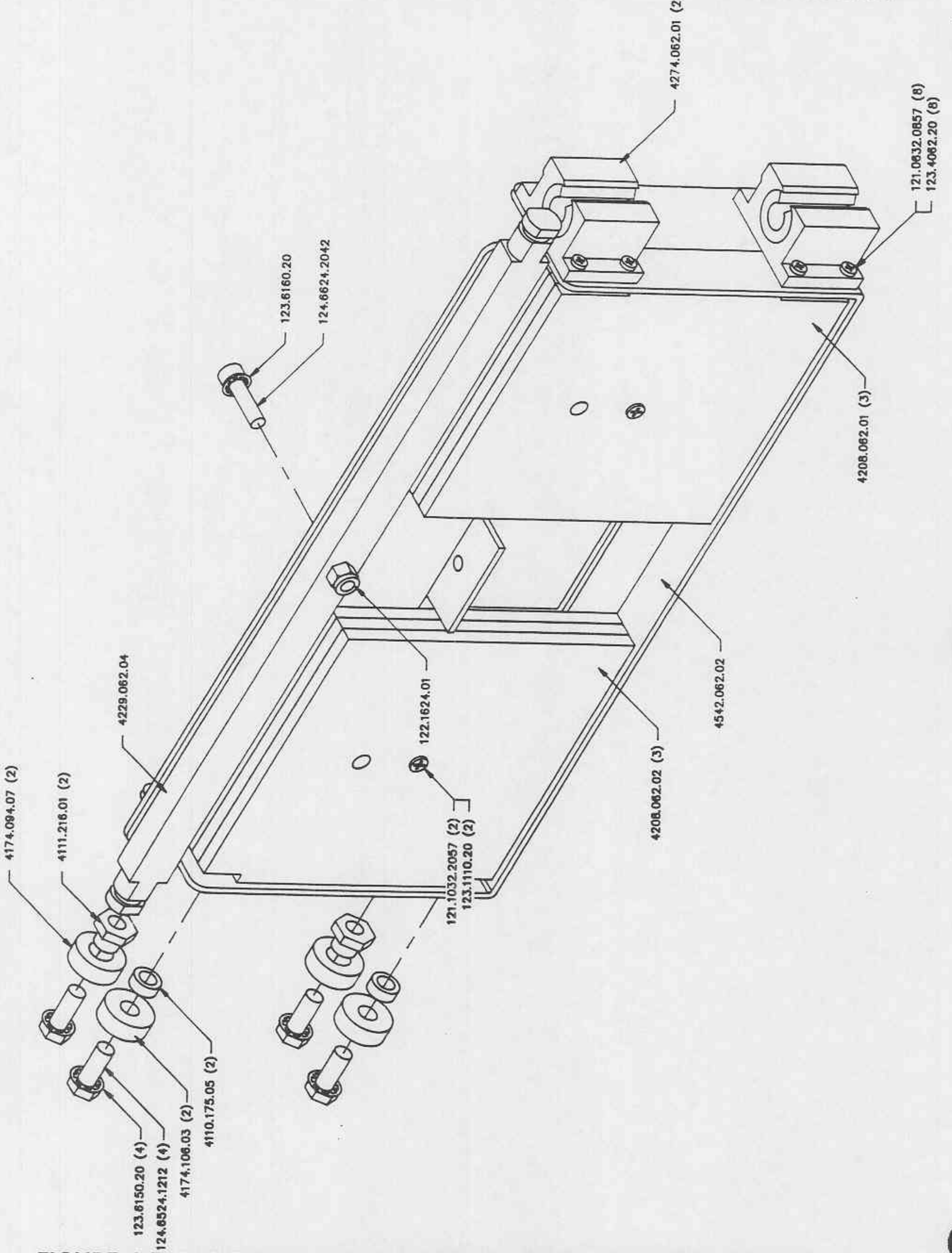
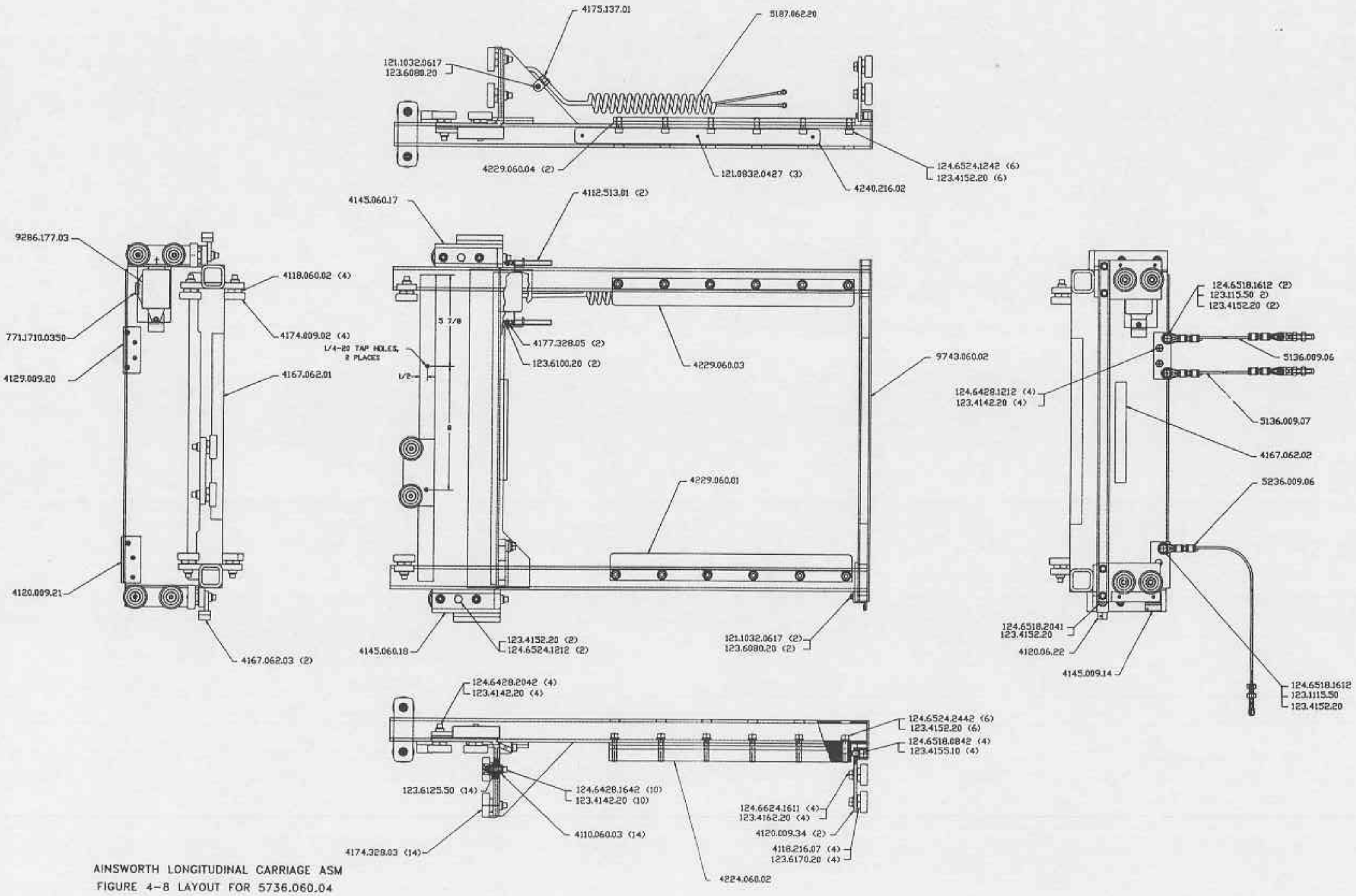

4274.062.01 (2)
121.0632.0857 (8)
123.4062.20 (8)
123.6160.20
124.6624.2042
4208.062.01 (3)
122.1624.01
4542.062.02
4208.062.02 (3)
4229.062.04
121.1032.2057 (2)
123.1110.20 (2)
4174.094.07 (2)
4111.216.01 (2)
123.6150.20 (4)
124.6524.1212 (4)
4174.106.03 (2)
4110.175.05 (2)

FIGURE 4-7 LAYOUT FOR TABLE TOWER CWT ASSY 5536.062.02

	Part Number	Description	Quantity
1.	121.0632.0857	6-32 X 1/2 Pan Steel Phillips Screw	8 EA
2.	121.1032.2057	10-32 X 1-1/4 Pan Steel Phlps Screw	2 EA
3.	122.1624.01	3/8-24 Elastic Stop Nut	1 EA
4.	123.1110.20	7/32ID 1/2OD 3/64Thk Stl SAE Washer	2 EA
5.	123.4062.20	#6 Medium Pattern Split Lockwasher	8 EA
6.	123.6150.20	5/16 Internal Tooth Steel Lockwashr	4 EA
7.	123.6160.20	3/8 Internal Tooth Steel Lockwasher	1 EA
8.	124.6524.1212	5/16-24 X 3/4 Hex Head Cap Screw	4 EA
9.	124.6624.2042	3/8-24 X 1-1/4 Socket Head Cap Scrw	1 EA
10.	4110.175.05	Bearing Spacer	2 EA
11.	4111.216.01	Eccentric Bushing	2 EA
12.	4174.094.07	29/32 OD 7/16 ID Ball Bearing	2 EA
13.	4174.106.03	29/32 OD 5/16 ID Ball Bearing	2 EA
14.	4208.062.01	SFD Tower Front Right Counterweight	3 EA
15.	4208.062.02	SFD Tower Front Left Counterweight	3 EA
16.	4229.062.04	Spot Device Tower Cwt Balance Bar	1 EA
17.	4274.062.01	Thomson Super-8 Opn Pillow Block	2 EA
18.	4542.062.02	Spot Device Tower Cwt Frame Wldmnt	1 EA

TABLE 4-4 PARTS LIST FOR 5536.062.02 TABLE/SFD TOWER CWT ASM


4175.137.01
5187.062.20
121.1032.0617
123.6080.20
4229.060.04 (2)
121.0832.0427 (3)
4240.216.02
124.6524.1242 (6)
123.4152.20 (6)
4145.060.17
4112.513.01 (2)
9286.177.03
4118.060.02 (4)
771.1710.0350
4174.009.02 (4)
4129.009.20
4167.062.01
1/4-20 TAP HOLES,
2 PLACES
1/2
5 7/8
8
4177.328.05 (2)
123.6100.20 (2)
4229.060.03
9743.060.02
4229.060.01
4120.009.21
4167.062.03 (2)
4145.060.18
123.4152.20 (2)
124.6524.1212 (2)
121.1032.0617 (2)
123.6080.20 (2)
124.6518.1612 (2)
123.115.50 2)
123.4152.20 (2)
5136.009.06
124.6428.1212 (4)
123.4142.20 (4)
5136.009.07
4167.062.02
5236.009.06
124.6518.2041
123.4152.20
4120.06.22
4145.009.14
124.6518.1612
123.1115.50
123.4152.20
124.6428.2042 (4)
123.4142.20 (4)
124.6524.2442 (6)
123.4152.20 (6)
124.6518.0842 (4)
123.4155.10 (4)
123.6125.50 (14)
124.6428.1642 (10)
123.4142.20 (10)
124.6624.1611 (4)
123.4162.20 (4)
4120.009.34 (2)
4118.216.07 (4)
123.6170.20 (4)
4110.060.03 (14)
4174.328.03 (14)
4224.060.02

AINSWORTH LONGITUDINAL CARRIAGE ASM
FIGURE 4-8 LAYOUT FOR 5736.060.04

SEE ADJACENT FOLD-OUT

FOR **FIGURE 4-8**

	Part Number	Description	Quantity
1.	121.0832.0427	8-32 X 1/4 Flat Steel Phillps Screw	3 EA
2.	121.1032.0617	10-32 X 3/8 Round Steel Phlps Screw	3 EA
3.	123.1115.50	11/32ID 11/16OD 1/16T Stl SAE Washr	3 EA
4.	123.4142.20	1/4 Medium Pattern Split Lockwasher	18 EA
5.	123.4152.20	5/16 Medium Pattrn Split Lockwasher	16 EA
6.	123.4155.10	5/16 Hi-Collar Split Lockwasher	4 EA
7.	123.4162.20	3/8 Medium Pattern Split Lockwasher	4 EA
8.	123.6080.20	#8 Internal Tooth Steel Lockwasher	3 EA
9.	123.6100.20	#10 Internal Tooth Steel Lockwashr	2 EA
10.	123.6170.20	7/16 Internal Tooth Steel Lockwashr	4 EA
11.	123.6175.50	15/32 Internal Tooth Stl Lockwasher	14 EA
12.	124.6428.1212	1/4-28 X 3/4 Hex Head Cap Screw	4 EA
13.	124.6428.1642	1/4-28 X 1 Socket Head Cap Screw	10 EA
14.	124.6428.2042	1/4-28 X 1-1/4 Socket Head Cap Scrw	4 EA
15.	124.6518.0842	5/16-18 X 1/2 Socket Head Cap Screw	4 EA
16.	124.6518.1212	5/16-18 X 3/4 Hex Head Cap Screw	2 EA
17.	124.6518.1612	5/16-18 X 1 Hex Head Cap Screw	1 EA
18.	124.6518.2042	5/16-18 X 1-1/4 Socket Hd Cap Screw	1 EA
19.	124.6524.1212	5/16-24 X 3/4 Hex Head Cap Screw	2 EA
20.	124.6524.1242	5/16-24 X 3/4 Socket Head Cap Screw	6 EA
21.	124.6524.2442	5/16-24 X 1-1/2 Socket Hd Cap Screw	6 EA
22.	124.6624.1611	3/8-24 X 1 Hex Head Cap Screw	4 EA
23.	4110.060.03	Shouldered Eccentric Stepped Washer	14 EA
24.	4112.513.01	Magnet Lock Stud	2 EA
25.	4118.060.01	203 Brng 7/32 Hd Shouldered Ecc Nut	10 EA
26.	4118.060.02	202 Bearing 7/32 Head Shlrd Ecc Nut	4 EA

TABLE 4-5 PARTS LIST FOR 5736.060.04 LONGITUDINAL CARRIAGE ASM

	Part Number	Description	Quantity	
27.	4118.216.07	203 Bearing 1/4 Head Eccentric Nut	4	EA
28.	4120.009.21	Ainsworth Carriage Cable Connect	1	EA
29.	4120.009.34	Ainsworth Carriage Bearing Block	2	EA
30.	4120.060.22	Answrth Lgtdnl Carg Chain Connector	1	EA
31.	4129.009.20	Additional Cwt Cable Connector	1	EA
32.	4145.009.14	Ainsw Assist Chain Carriage Anchor	1	EA
33.	4145.060.17	Answrth Lgtdnl Carg Rt Bmpr Bracket	1	EA
34.	4145.060.18	Answrth Lgtdnl Carg Lt Bmpr Bracket	1	EA
35.	4167.062.01	7/16 X 3/4 X 12 Sponge Rubbr Bumper	1	EA
36.	4167.062.02	7/16 X 3/4 X 6.5 Sponge Rbbr Bumper	1	EA
37.	4167.062.03	7/16 X 3/4 X 3 Sponge Rubber Bumper	2	EA
38.	4174.009.02	202 Double Shield Ball Bearing	4	EA
39.	4174.328.03	Double Shield 203 Ball Bearing	14	EA
40.	4175.137.01	1/4 Inch Cable Clamp	1	EA
41.	4177.328.05	Crittenden Bleeder Spring	2	EA
42.	4224.060.02	Ainswrth Lngtdnl Carg Bar	1	EA
43.	4229.060.01	Ainsworth Lgtdnl Lh Carriage Track	1	EA
44.	4229.060.03	Ainsworth Lgtdnl Rh Carriage Track	1	EA
45.	4229.060.04	Ainsworth Lgtdnl Carg Track Spacer	2	EA
46.	4240.216.02	Lateral Carriage Lock Strip	1	EA
47.	5136.009.06	Ans Right Added Counterweight Cable	1	EA
48.	5136.009.07	Left Additional Counterweight Cable	1	EA
49.	5187.062.20	Lat/long Carriage Lock Coiled Cable	1	EA
50.	5236.009.06	Ainsworth Foot End Carriage Cable	1	EA
51.	771.1710.0350	100 Mfd 50 Volt Electyc Capacitor	1	EA
52.	9286.177.03	28 Volt Magnet	1	EA

TABLE 4-5 P/L FOR 5736.060.04 LONGITUDINAL CARRIAGE ASM (continued)

	Part Number	Description	Quantity
53.	9743.060.02	Ainsworth Longitudinal Carriage	1 EA

TABLE 4-5 P/L FOR 5736.060.04 LONGITUDINAL CARRIAGE ASM (continued)

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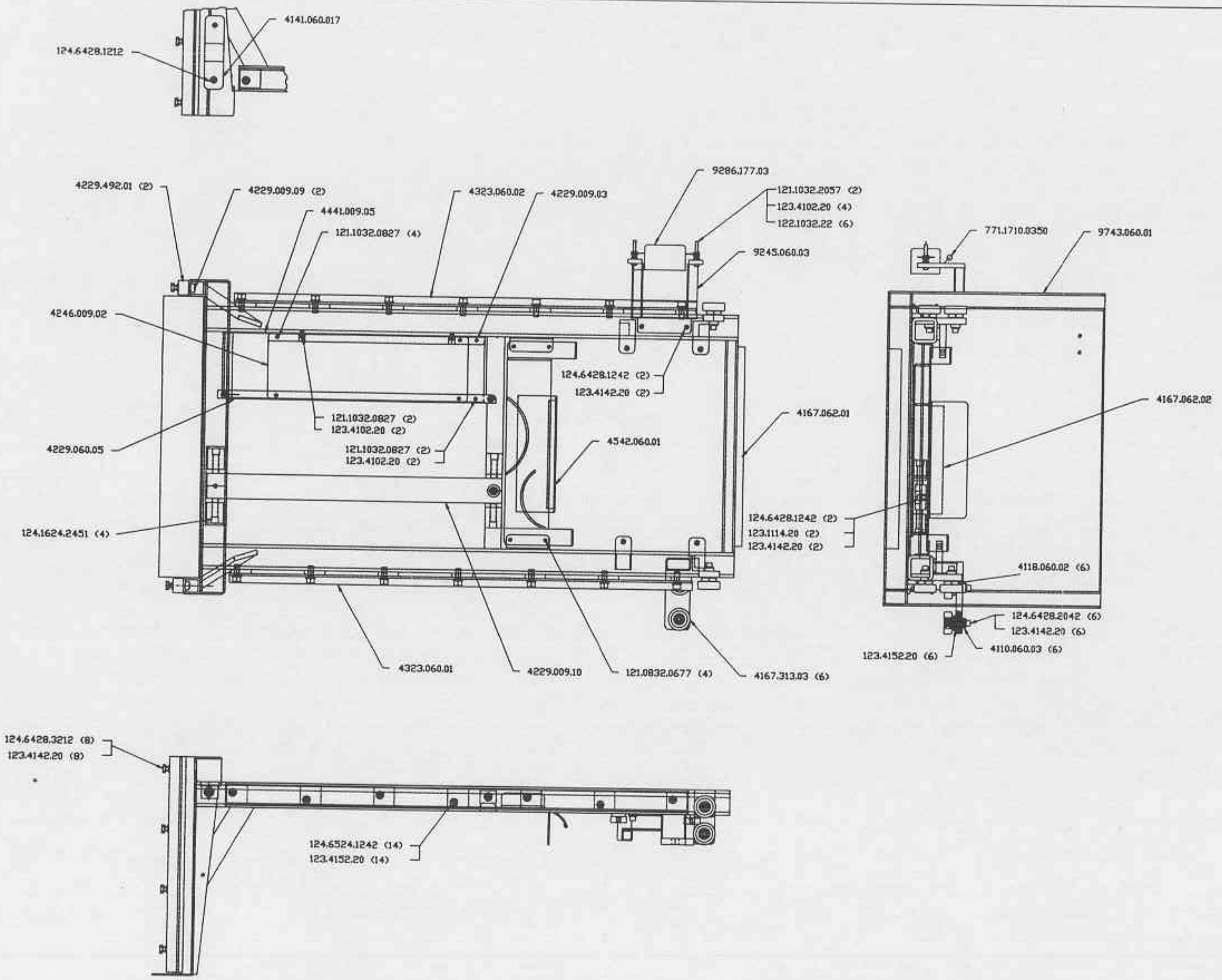

4141.060.017
124.6428.1212
4229.492.01 (2)
4229.009.09 (2)
4441.009.05
121.1032.0827 (4)
4323.060.02
4229.009.03
9286.177.03
121.1032.2057 (2)
123.4102.20 (4)
122.1032.22 (6)
9245.060.03
771.1710.0350
9743.060.01
4246.009.02
124.6428.1242 (2)
123.4142.20 (2)
4167.062.02
121.1032.0827 (2)
123.4102.20 (2)
4167.062.01
121.1032.0827 (2)
123.4102.20 (2)
4229.060.05
4542.060.01
124.6428.1242 (2)
123.1114.20 (2)
123.4142.20 (2)
124.1624.2451 (4)
4118.060.02 (6)
124.6428.2042 (6)
123.4142.20 (6)
123.4152.20 (6)
4110.060.03 (6)
4323.060.01
4229.009.10
121.0832.0677 (4)
4167.313.03 (6)
124.6428.3212 (8)
123.4142.20 (8)
124.6524.1242 (14)
123.4152.20 (14)

AINSWORTH LATERAL CARRIAGE ASM
FIGURE 4-9 LAYOUT FOR 5736.060.05

	Part Number	Description	Quantity	
1.	121.0832.0677	8-32 X 3/8 Undrcut Flat Head Screw	4	EA
2.	121.1032.0827	10-32 X 1/2 Flat Steel Philps Screw	4	EA
3.	121.1032.2057	10-32 X 1-1/4 Pan Steel Phlps Screw	2	EA
4.	122.1032.22	10-32 Double Chamfered Hex Nut Stl	6	EA
5.	123.1114.20	9/32ID 5/8OD 1/16Thk Stl SAE Washer	10	EA
6.	123.4102.20	#10 Medium Pattern Split Lockwasher	6	EA
7.	123.4142.20	1/4 Medium Pattern Split Lockwasher	10	EA
8.	123.4152.20	5/16 Medium Pattrn Split Lockwasher	14	EA
9.	124.1624.2451	3/8-24 X 1-1/2 Self-Locking St Scrw	4	EA
10.	124.6428.1212	1/4-28 X 3/4 Hex Head Cap Screw	1	EA
11.	124.6428.1242	1/4-28 X 3/4 Socket Head Cap Screw	4	EA
12.	124.6428.2042	1/4-28 X 1-1/4 Socket Head Cap Scrw	6	EA
13.	124.6428.3212	1/4-28 X 2 Hex Head Cap Screw	8	EA
14.	124.6524.1242	5/16-24 X 3/4 Socket Head Cap Screw	14	EA
15.	4110.060.03	Shouldered Eccentric Stepped Washer	6	EA
16.	4118.060.02	202 Bearing 7/32 Head Shlrd Ecc Nut	6	EA
17.	4167.062.01	7/16 X 3/4 X 12 Sponge Rubbr Bumper	1	EA
18.	4167.062.02	7/16 X 3/4 X 6.5 Sponge Rbbr Bumper	1	EA
19.	4174.009.02	202 Double Shield Ball Bearing	6	EA
20.	4229.009.03	Ainsworth Right Hand Side Support	1	EA
21.	4229.009.09	Scholz Tower Nut Strip	2	EA
22.	4229.009.10	Answrth Laterl Carriage Guide Track	1	EA
23.	4229.060.05	Ainsworth Left Hand Side Support	1	EA
24.	4229.492.01	5/8 Scholz Tower Spacer Strip	2	EA
25.	4246.009.02	Cable Support Cover	1	EA
26.	4323.060.01	Ainsworth Lateral Carriage LH Track	1	EA

TABLE 4-6 PARTS LIST FOR 5736.060.05 LATERAL CARRIAGE ASM

	Part Number	Description	Quantity
27.	4323.060.02	Ainsworth Lateral Carriage RH Track	1 EA
28.	4441.009.05	Ainswrth Curved Cable Support Cover	1 EA
29.	4542.060.01	Ainsworth Cable Support Bracket	1 EA
30.	771.1710.0350	100 Mfd 50 Volt Electyc Capacitor	1 EA
31.	9245.060.03	Ainsworth Transverse Lock Bracket	1 EA
32.	9286.177.03	28 Volt Magnet	1 EA
33.	9743.060.01	Ainsworth Lateral Carriage	1 EA

TABLE 4-6 PARTS LIST FOR 5736.060.05 LATERAL CARRIAGE ASM (continued)

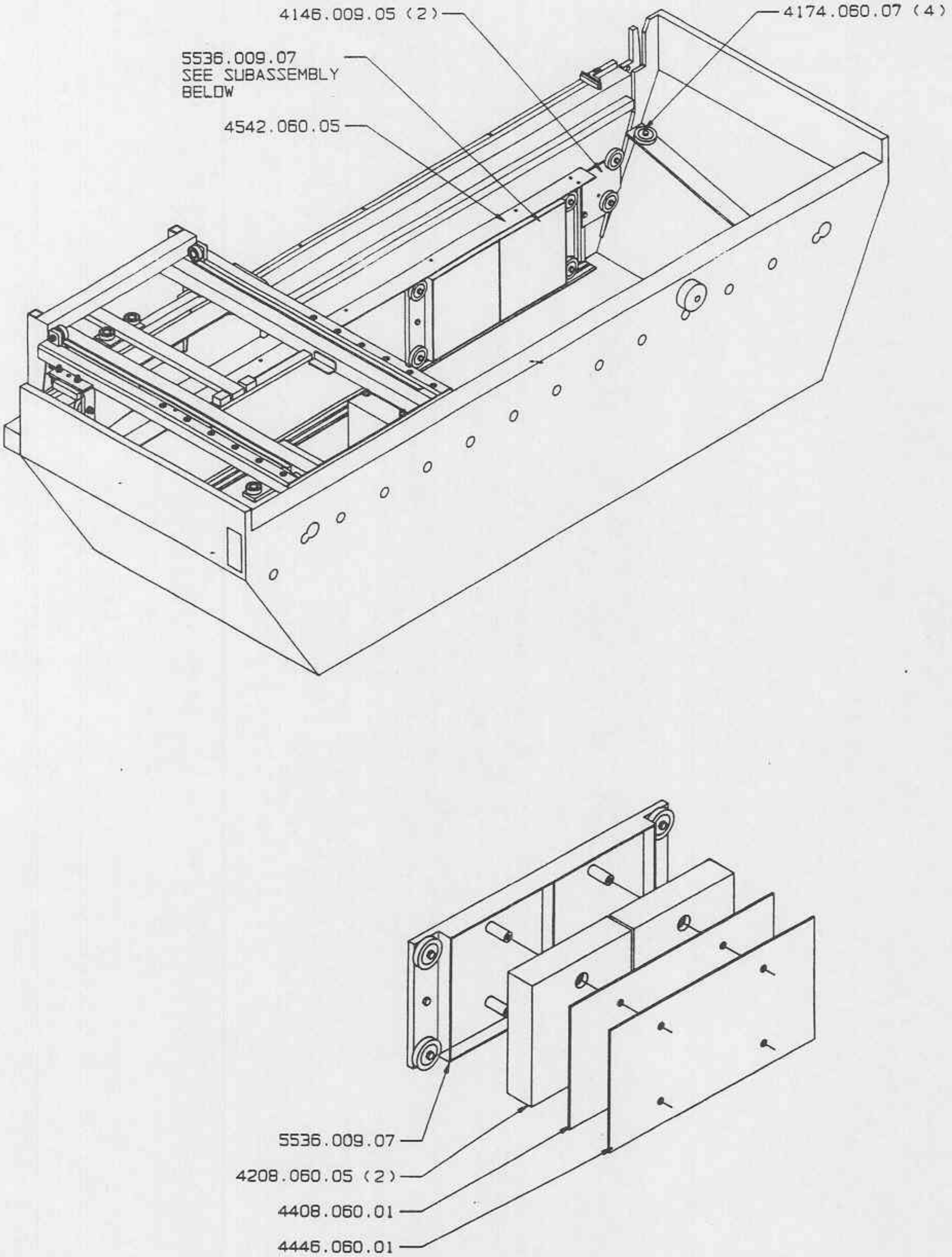

4146.009.05 (2)
4174.060.07 (4)
5536.009.07
SEE SUBASSEMBLY
BELOW
4542.060.05
5536.009.07
4208.060.05 (2)
4408.060.01
4446.060.01

FIGURE 4-10 LAYOUT FOR TABLE BODY ASSEMBLY 5736.062.02

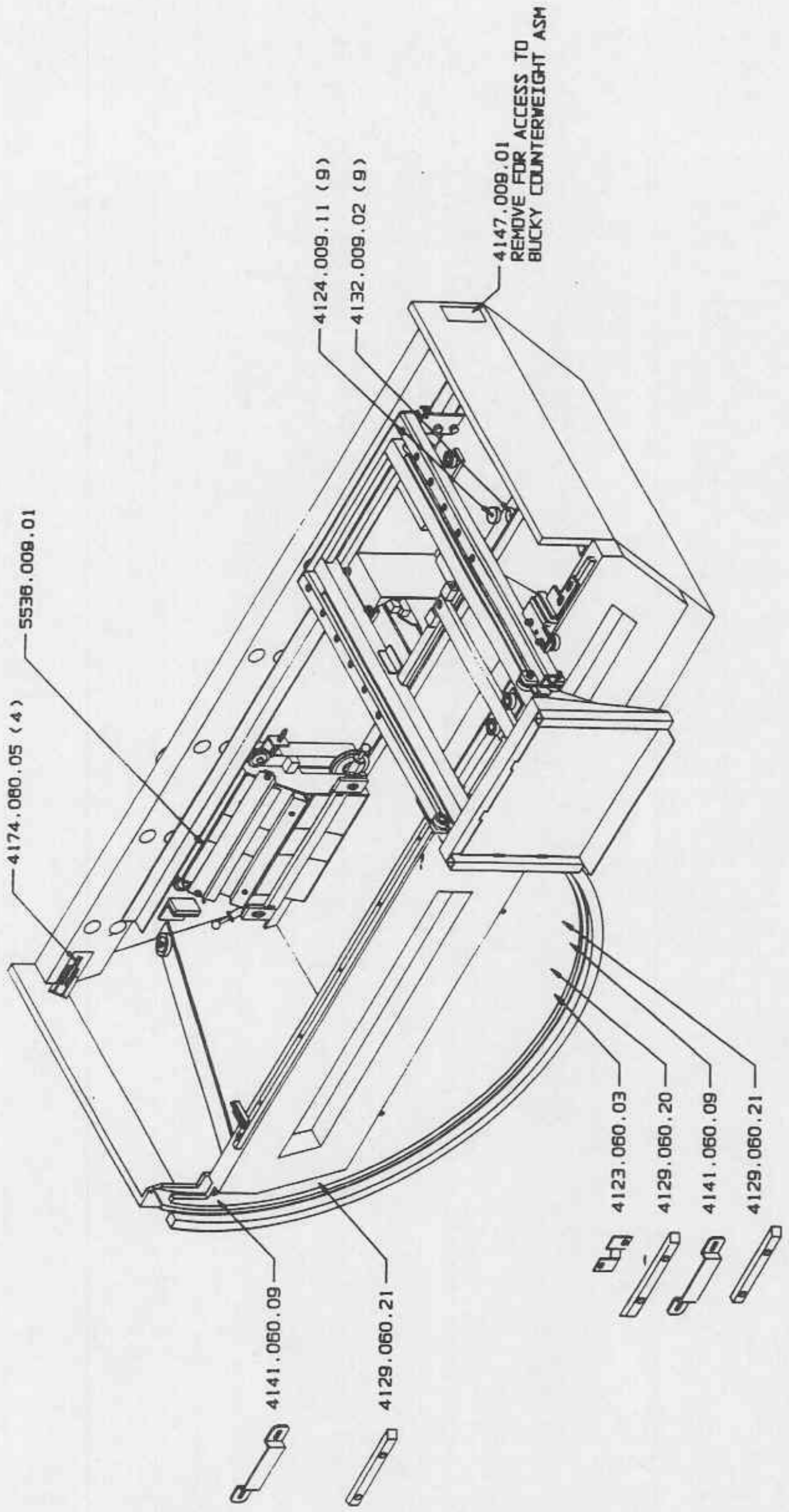
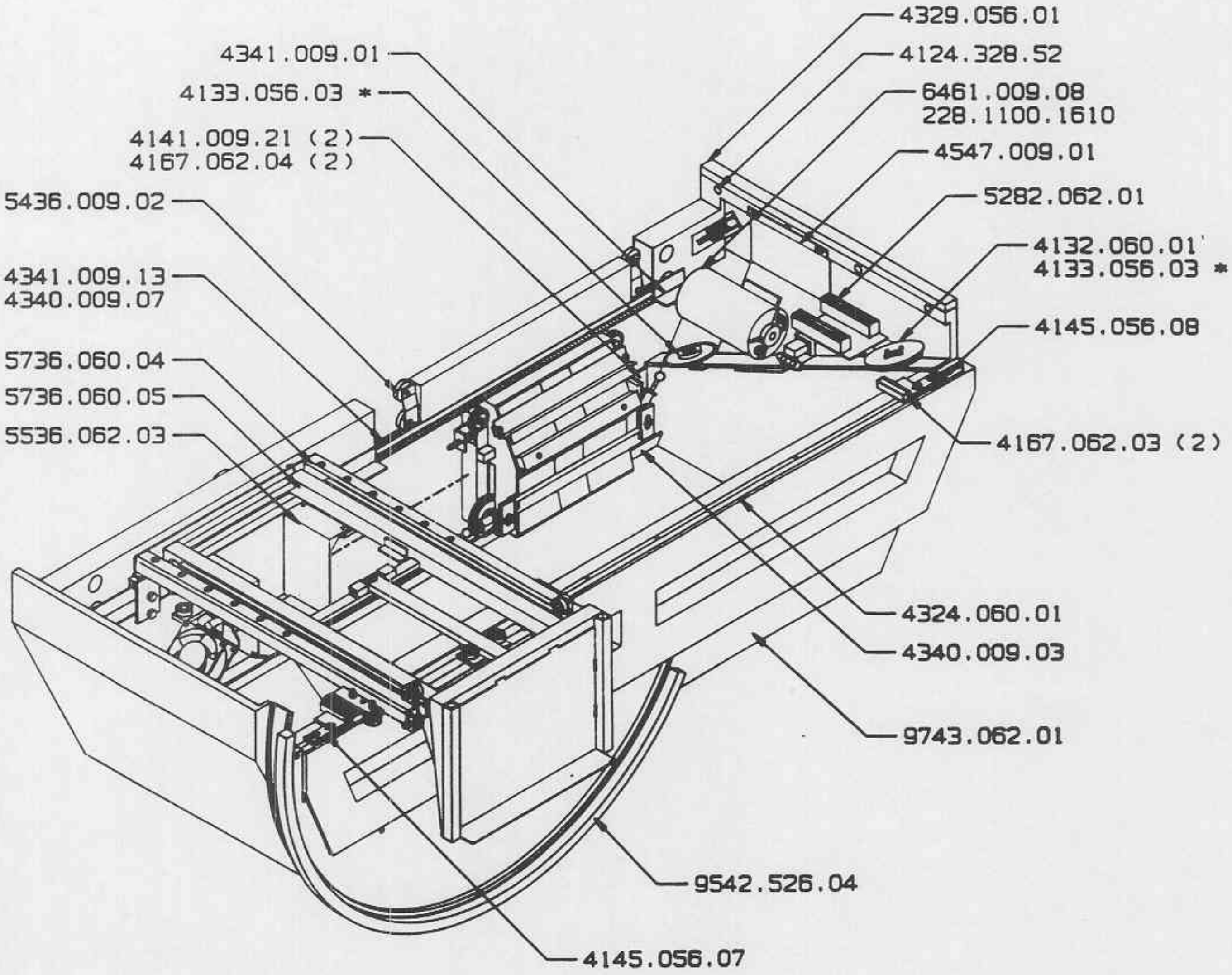

4124.009.11 (9)
4132.009.02 (9)
4147.009.01
REMOVE FOR ACCESS TO
BUCKY COUNTERWEIGHT ASM
5536.009.01
4174.060.05 (4)
4123.060.03
4129.060.20
4141.060.09
4129.060.21
4141.060.09
4129.060.21

FIGURE 4-10 LAYOUT FOR TABLE BODY ASSEMBLY 5736.062.02 (continued)


4341.009.01
4133.056.03 *
4141.009.21 (2)
4167.062.04 (2)
5436.009.02
4341.009.13
4340.009.07
5736.060.04
5736.060.05
5536.062.03
4329.056.01
4124.328.52
6461.009.08
228.1100.1610
4547.009.01
5282.062.01
4132.060.01
4133.056.03 *
4145.056.08
4167.062.03 (2)
4324.060.01
4340.009.03
9743.062.01
9542.526.04
4145.056.07

* Part Includes:
124.6616.2442
123.6160.20
4111.060.05
4174.009.02
4110.060.04
4111.009.17
123.4162.20
122.1616.22

FIGURE 4-10 LAYOUT FOR TABLE BODY ASSEMBLY 5736.062.02 (continued)

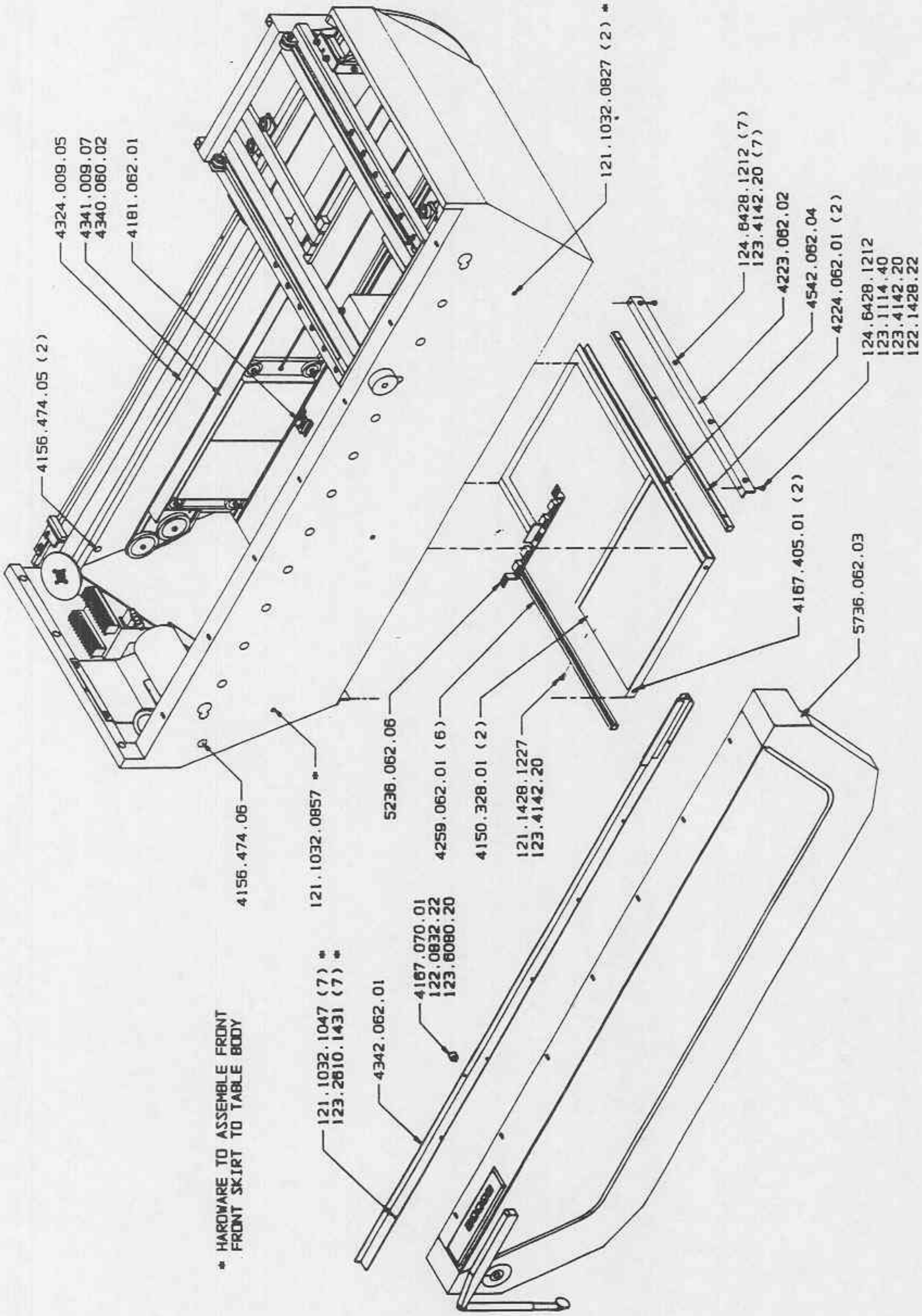

4324.009.05
4341.009.07
4340.060.02
4181.062.01
4156.474.05 (2)
121.1032.0827 (2) *
124.6428.1212 (7)
123.4142.20 (7)
4223.062.02
4542.062.04
4224.062.01 (2)
124.6428.1212
123.1114.40
123.4142.20
122.1428.22
4167.405.01 (2)
5736.062.03
4156.474.06
121.1032.0857 *
5238.062.06
4259.062.01 (6)
4150.328.01 (2)
121.1428.1227
123.4142.20
* HARDWARE TO ASSEMBLE FRONT
FRONT SKIRT TO TABLE BODY
121.1032.1047 (7) *
123.2610.1431 (7) *
4342.062.01
4167.070.01
122.0832.22
123.6080.20

FIGURE 4-10 LAYOUT FOR TABLE BODY ASSEMBLY 5736.062.02 (continued)

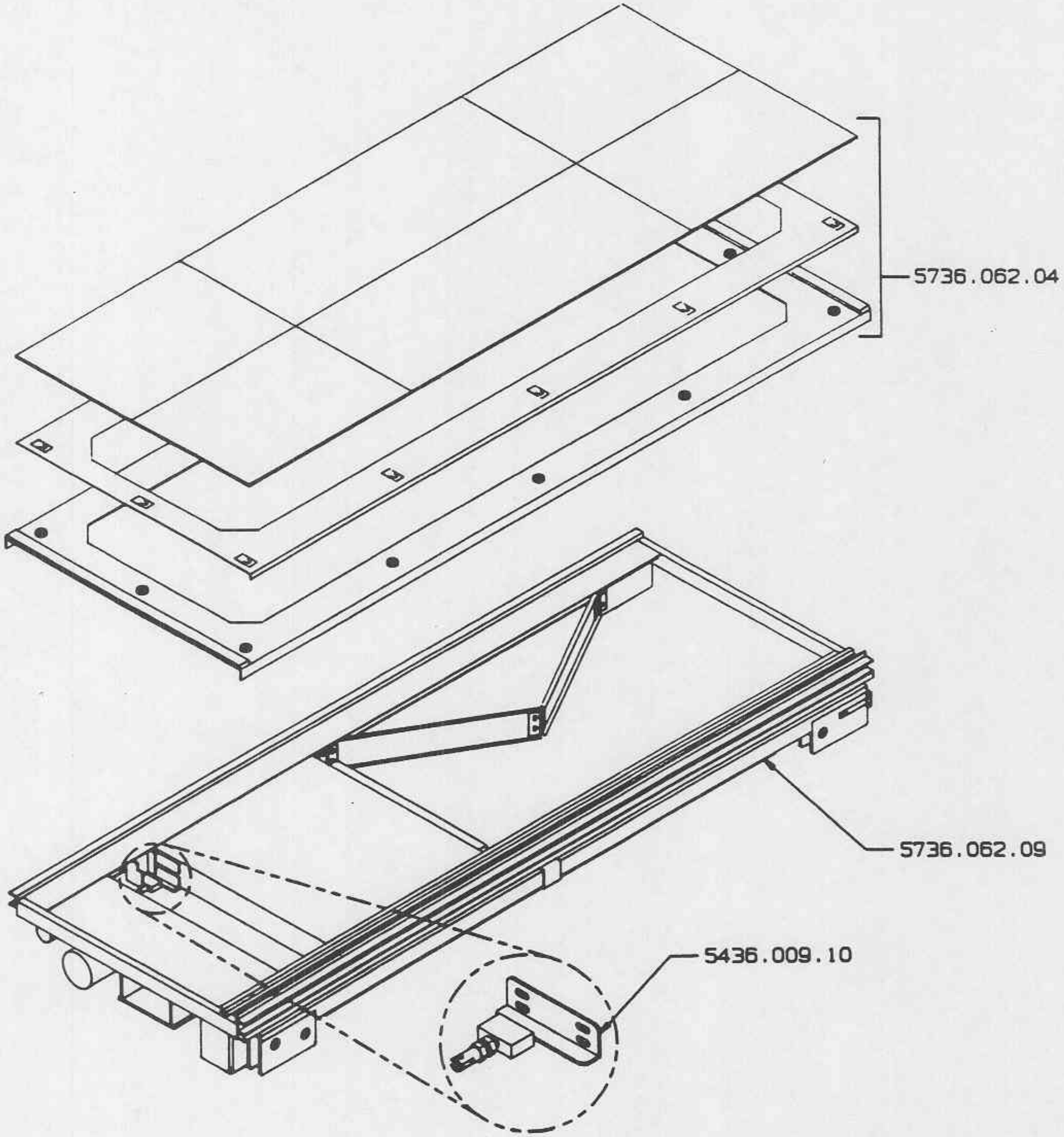

5736.062.04
5736.062.09
5436.009.10

FIGURE 4-10 LAYOUT FOR TABLE BODY ASSEMBLY 5736.062.02 (continued)

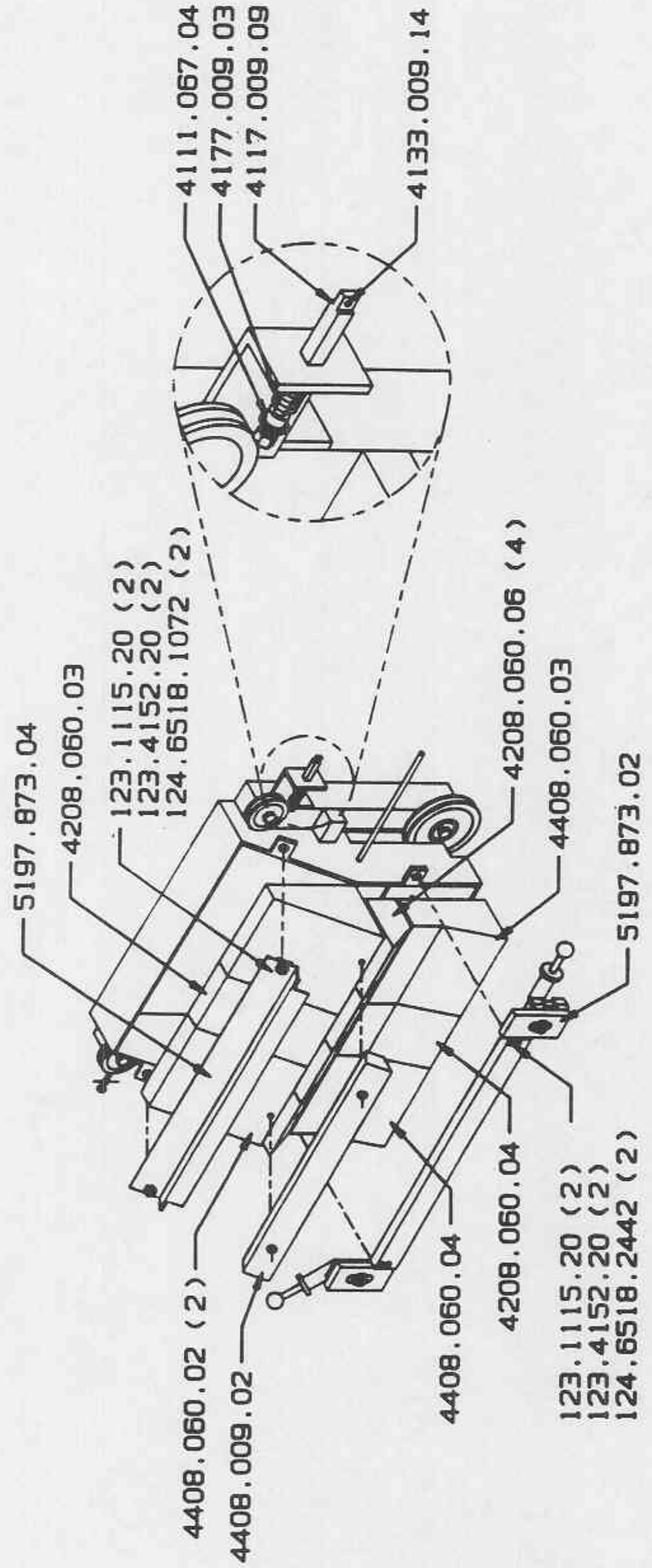

4111.067.04
4177.009.03
4117.009.09
4133.009.14
5197.873.04
4208.060.03
123.1115.20 (2)
123.4152.20 (2)
124.6518.1072 (2)
4208.060.06 (4)
4408.060.03
5197.873.02
4408.060.02 (2)
4408.009.02
4408.060.04
4208.060.04
123.1115.20 (2)
123.4152.20 (2)
124.6518.2442 (2)

FIGURE 4-10 LAYOUT FOR TABLE BODY ASSEMBLY 5736.062.02 (continued)

	Part Number	Description	Quantity	
1.	121.0440.1067	4-40 X 5/8 Phil Truss Hd Mach Screw	2	EA
2.	121.0632.1427	6-32 X 7/8 Flat Steel Philips Screw	6	EA
3.	121.1032.0647	10-32 X 3/8 Filstr Steel Phlp Screw	4	EA
4.	121.1032.0817	10-32 X 1/2 Round Steel Phlps Screw	6	EA
5.	121.1032.1247	10-32 X 3/4 Filstr Steel Phlp Screw	9	EA
6.	121.1518.2427	5/16-18 X 1-1/2 Phlps Flat Hd Screw	4	EA
7.	122.1032.22	10-32 Double Chamfered Hex Nut Stl	9	EA
8.	122.1428.0420	1/4-28 Light Weight Stop Nut	1	EA
9.	123.1114.20	9/32ID 5/8OD 1/16Thk Stl SAE Washer	2	EA
10.	123.4142.20	1/4 Medium Pattern Split Lockwasher	14	EA
11.	123.4162.20	3/8 Medium Pattern Split Lockwasher	2	EA
12.	123.4172.20	7/16 Medium Pattrn Split Lockwasher	1	EA
13.	123.6100.20	#10 Internal Tooth Steel Lockwashr	24	EA
14.	123.6200.20	5/8 X .046 Internal Tooth Lockwashr	1	EA
15.	124.6420.0861	1/4-20x1/2 Flt Hd Sckt Blk Oxd Scrw	8	EA
16.	124.6420.1212	1/4-20 X 3/4 Hex Head Cap Screw	2	EA
17.	124.6420.1612	1/4-20 X 1 Hex Head Cap Screw	2	EA
18.	124.6420.2412	1/4-20 X 1-1/2 Hex Head Cap Screw	2	EA
19.	124.6428.1242	1/4-28 X 3/4 Socket Head Cap Screw	20	EA
20.	124.6428.1412	1/4-28 X 7/8 Hex Head Cap Screw	10	EA
21.	124.6616.2012	3/8-16 X 1-1/4 Hex Head Cap Screw	2	EA
22.	124.6714.1641	7/16-14 X 1 Socket Head Cap Screw	1	EA
23.	228.1100.01	1/4P #25 Single Sprocket Chain	4	FT
24.	228.1100.1610	25 16T 1/2B Sprocket W/Setscrw Hole	1	EA
25.	228.1110.01	3/8P #35 Single Sprocket Chain	7	FT
26.	4110.060.04	Ainsworth 202 Brng Retainer Washer	2	EA

TABLE 4-7 PARTS LIST FOR 5736.062.02 TABLE BODY ASM

	Part Number	Description	Quantity
27.	4111.009.17	Ainsworth Adjust Sprocket Spacer	2 EA
28.	4111.060.05	Answrth Hd End Carg Sprocket Spacer	2 EA
29.	4111.067.04	Bearing Bushing	1 EA
30.	4117.009.09	Ainsworth Spring Chain Anchor Stud	1 EA
31.	4123.060.03	Hrzntl Stop Swtch Centerng Actuator	1 EA
32.	4124.009.11	Ainsworth 7/32 Track Spacer	9 EA
33.	4124.328.52	Rad/Fluoroscopic Table Top Nut	8 EA
34.	4129.060.20	Center Slow Down Switch Cam	1 EA
35.	4129.060.21	End Slow Down Switch Cam	2 EA
36.	4132.009.02	Ainsworth 7/32" Track Spacer Shim	9 EA
37.	4132.060.01	Ains Hd End Carriage Sprockt Washer	1 EA
38.	4133.009.14	25 1 Connecting Link	2 EA
39.	4133.056.03	36T 35 Idler Sprocket	2 EA
40.	4133.216.29	ASA .35 Connecting Link	2 EA
41.	4139.873.02	1/2D T-Hndl Sngl Actng Ball Lck Pin	1 EA
42.	4139.873.06	3/64" OD 12" Long Typ B Steel Cable	1 EA
43.	4140.851.02	V3L Micro Switch Nut Strip	1 EA
44.	4141.009.21	Stop For Ainsworth Counterweight	2 EA
45.	4141.060.09	Ainsworth Limit Switch Cam	2 EA
46.	4145.056.07	Left Carriage Body Bumper Bracket	1 EA
47.	4145.056.08	Right Carriage Body Bumper Bracket	1 EA
48.	4146.009.05	Ainsworth Pulley Plate	2 EA
49.	4147.009.01	Ainsworth Bucky Cwt Slot Cover	1 EA
50.	4147.062.01	Table Tilt Interlock Switch Bracket	1 EA
51.	4150.328.01	R/F Table 6" X 24" Black Step Tread	2 EA
52.	4156.474.05	7/8 X 5/8 Snap Bushing	2 EA

TABLE 4-7 P/L FOR 5736.062.02 TABLE BODY ASM (continued)

	Part Number	Description	Quantity	
53.	4156.474.06	1-3/32 X 7/16 Snap Bushing	1	EA
54.	4167.062.03	7/16 X 3/4 X 3 Sponge Rubber Bumper	2	EA
55.	4167.062.04	7/16 X 1.5 X 2.5 Sponge Rbbr Bumper	2	EA
56.	4167.070.01	8-32 X 3/8 Stud Rubber Bumper	1	EA
57.	4167.405.01	1/4 ID 1/2 OD Plug Bumper	2	EA
58.	4174.009.02	202 Double Shield Ball Bearing	2	EA
59.	4174.060.05	3-1/2 x1/4 Alum Pulley Ball Bearing	4	EA
60.	4174.060.07	2" X 1/4 Alum Pulley Ball Bearing	4	EA
61.	4177.009.03	Carriage Assist Chain Spring	1	EA
62.	4181.062.01	Micro Sw-V3L-121-D8, 1.285 Arm	1	EA
63.	4208.060.03	Ainsworth Upper Lead Counterweight	1	EA
64.	4208.060.04	Ainsworth Lower Lead Counterweight	1	EA
65.	4208.060.05	Ainswrth Additional Lead Counterwt	2	EA
66.	4208.060.06	Low Table Middle Lead Counterweight	4	EA
67.	4223.062.02	Military Table Step Support Angle	1	EA
68.	4224.062.01	Military Table Mounting Step Rail	2	EA
69.	4259.062.01	27-7/8 x 1/2 x 1/8 Nylatrn GS Strip	6	EA
70.	4324.009.05	Ainswrth 90-15 Carriage Bearing Bar	1	EA
71.	4324.060.01	Ainswrth Carriage Upper Bearing Bar	1	EA
72.	4329.056.01	Radiographc/Fluoro Table Top Spacer	2	EA
73.	4340.009.03	Lower Track For Ainsworth Counterwt	1	EA
74.	4340.009.07	Ainsworth Main Cwt Strip Shim	4	EA
75.	4340.060.02	Ainsworth Additional Cwt Strip Shim	2	EA
76.	4341.009.01	Ainsworth Main Counterweight Strip	3	EA
77.	4341.009.07	Ainsworth Additional Cwt Strip	2	EA
78.	4341.009.13	Ainsworth Table Body Front Track	1	EA

TABLE 4-7 P/L FOR 5736.062.02 TABLE BODY ASM (continued)

	Part Number	Description	Quantity
79.	4342.062.01	Military Table Top Slot Bracket	1 EA
80.	4408.009.02	Aux Counterweight For Intensifier	1 EA
81.	4408.060.01	Ainsworth 1/8 Thick Aux Carg Cwt	4 EA
82.	4408.060.02	Upper Lead Counter weight	2 EA
83.	4408.060.03	Lower Right Lead Counterweight	1 EA
84.	4408.060.04	Lower Left Lead Counterweight	1 EA
85.	4446.060.01	Ainsworth Aux Carg Cwt Front Sheet	1 EA
86.	4459.062.01	Military Table Rear Opening Guard	1 EA
87.	4542.060.05	Ainsworth Additional Cwt Channel	1 EA
88.	4542.062.04	Military Mounting Step Weldment Asm	1 EA
89.	4547.009.01	Power Assist Motor Mounting Bracket	1 EA
90.	5236.062.06	Mounting Step Magnetic Catch Switch	1 EA
91.	5282.062.01	Military Table HE Terminal Assembly	1 EA
92.	5436.009.02	Ainsworth Bucky Counterweight Asm	1 EA
93.	5436.009.10	Bucky Cable Anchor Assembly	1 EA
94.	5536.009.01	Ainsworth Carriage Counterwt. Asm	1 EA
95.	5536.009.07	Ainsworth Auxiliary Carriage Cwt	1 EA
96.	5536.062.03	X-Ray Tube & Cllmtr Mntng Frame Asm	1 EA
97.	5736.060.04	Ainsworth Longitudinal Carriage Asm	1 EA
98.	5736.060.05	Ainsworth Lateral Carriage Assembly	1 EA
99.	5736.062.03	Military R-F Table Front Skirt Asm	1 EA
100.	5736.062.04	Milit. Bearing Top Outer Frame Asm	1 EA
101.	5736.062.09	Military Bearing Top Inner Frm Asm	1 EA
102.	6461.009.08	1/8 HP 500 RPM Motor	1 EA
103.	9245.062.05	Military Tbl/Carg Shipping Bracket	1 EA
104.	9542.526.04	Bearing Chain Guide Assembly	1 EA
105.	9743.062.01	Military Welded Table Body	1 EA

TABLE 4-7 P/L FOR 5736.062.02 TABLE BODY ASM (continued)

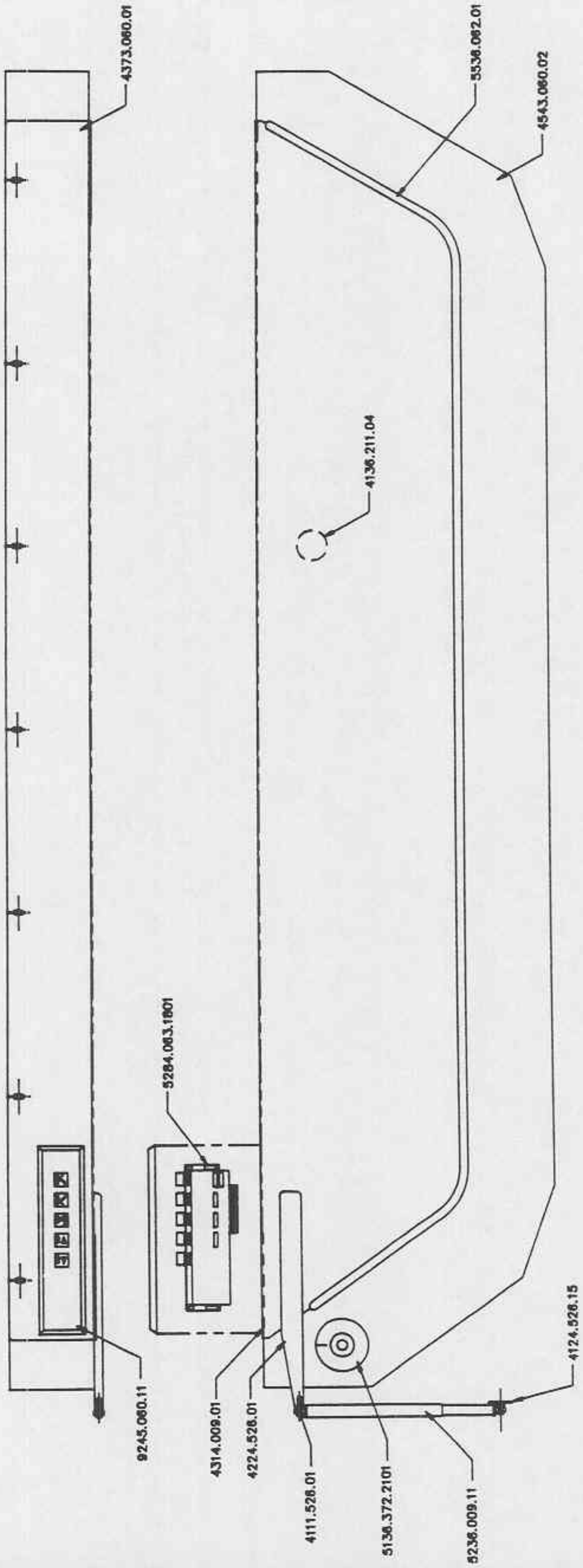
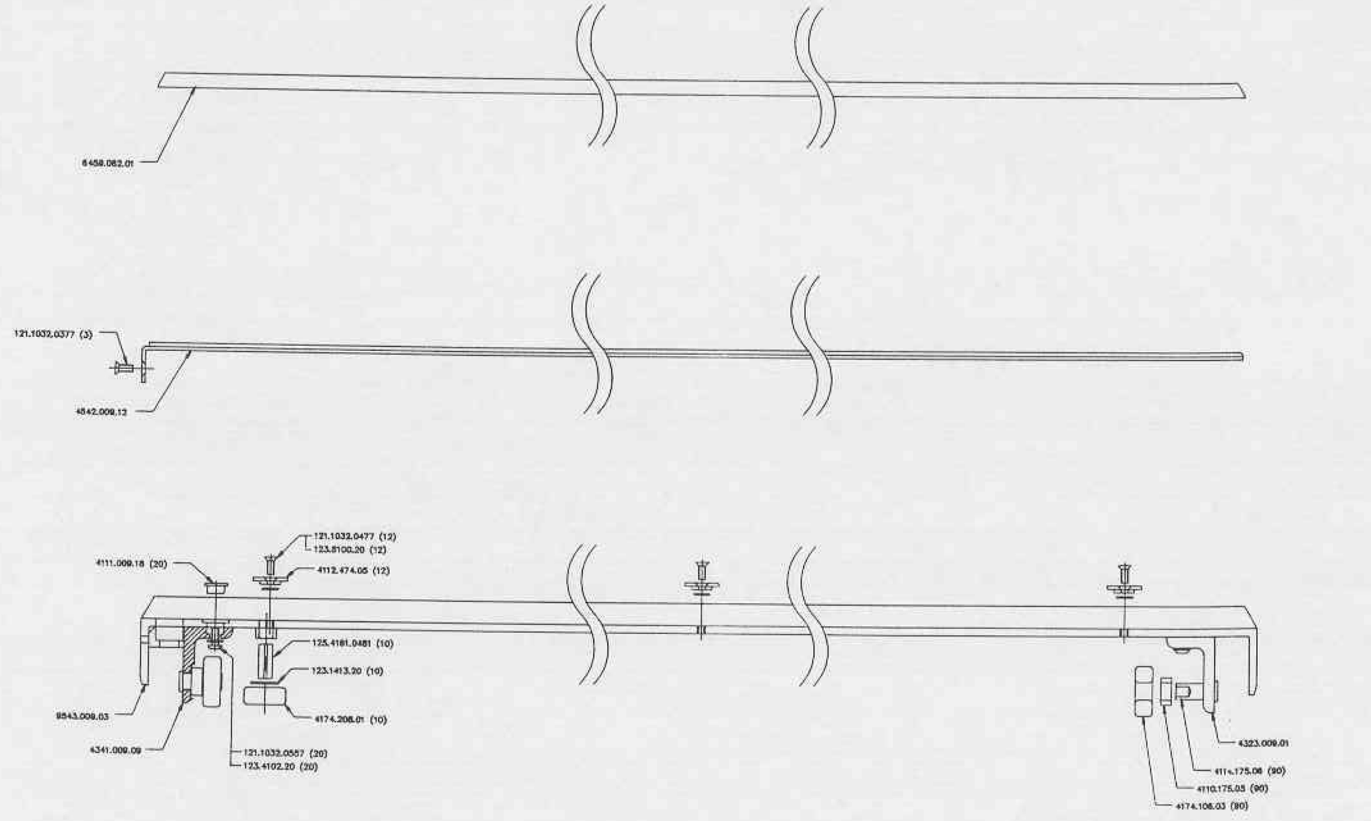

4373.060.01
5536.062.01
4543.060.02
4136.211.04
5284.063.1801
9245.060.11
4314.009.01
4224.528.01
4111.528.01
5136.372.2101
5236.009.11
4124.528.15

FIGURE 4-11 LAYOUT FOR TABLE FRONT SKIRT ASSY 5736.062.03

	Part Number	Description	Quantity
1.	4111.526.01	X-Ray Table Pivot Bushing	1 EA
2.	4124.526.15	Ainsworth Spring Housing Pivot	1 EA
3.	4136.211.04	2 Inch Diameter Hole Plug Button	1 EA
4.	4224.526.01	Pivot Bar	1 EA
5.	4314.009.01	Ainsworth Radiatn. Shield Hinge Pin	1 EA
6.	4373.060.01	Ainsworth Five Sw Plate Small Hinge	1 EA
7.	4543.060.02	Ainsworth Low Table Front Skirt	1 EA
8.	5136.372.2102	Prescott Red Tilt Indicatr Assembly	1 EA
9.	5236.009.11	Ainsworth Hinge Spring Assembly	1 EA
10.	5284.062.1801	MXT 90/15 Tbl 5 Function Cntrl Sw	1 EA
11.	5536.062.01	Military Table Radiation Shield Asm	1 EA
12.	9245.060.11	Ainswort Body Five Sw Cntrl Plate	1 EA

TABLE 4-8 PARTS LIST FOR 5736.062.03 R-F TABLE FRONT SKIRT ASM

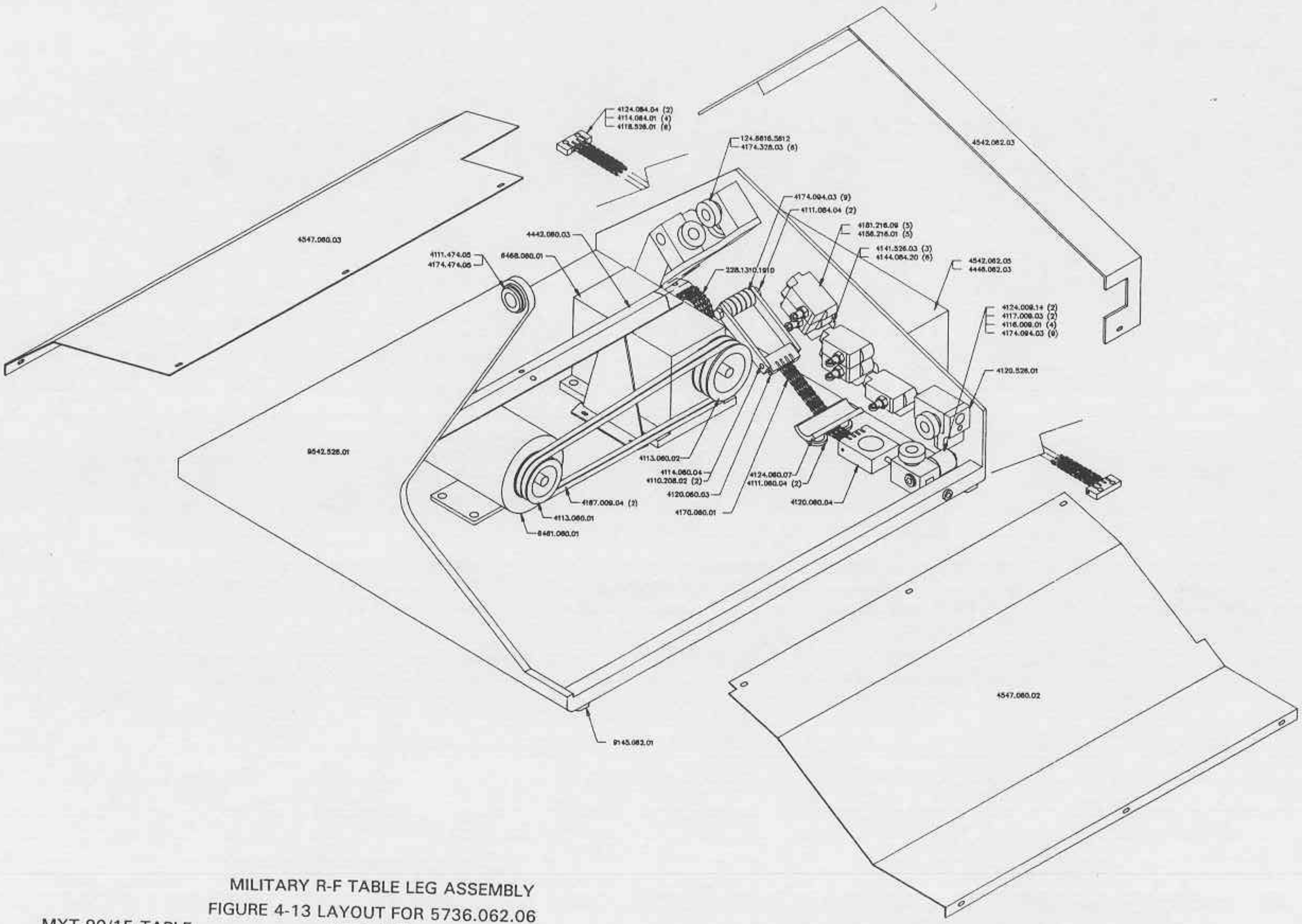

6458.062.01
121.1032.0377 (3)
4542.009.12
121.1032.0477 (12)
123.8100.20 (12)
4111.009.18 (20)
4112.474.05 (12)
125.4181.0481 (10)
123.1413.20 (10)
4174.208.01 (10)
9543.009.03
4341.009.09
121.1032.0557 (20)
123.4102.20 (20)
4323.009.01
4114.175.06 (90)
4110.175.05 (90)
4174.106.03 (90)

MILIT. BEARING TOP OUTER FRAME ASM

FIGURE 4-12 LAYOUT FOR 5736.062.04

	Part Number	Description	Quantity	
1.	121.1032.0377	10-32 X 3/16 Flat Undercut Stl Scrw	3	EA
2.	121.1032.0477	10-32 X 1/4 Flat Undercut Stl Screw	12	EA
3.	121.1032.0557	10-32 X 5/16 Pan Steel Philps Screw	20	EA
4.	123.1413.20	17/64I 1/20d 1/32T Stl Elect.Washer	10	EA
5.	123.4102.20	#10 Medium Pattern Split Lockwasher	20	EA
6.	123.6100.20	#10 Internal Tooth Steel Lockwashr	12	EA
7.	125.4161.0481	1/4 OD X 5/8 Long .048 Thck Rollpin	10	EA
8.	4110.175.05	Bearing Spacer	90	EA
9.	4111.009.18	Ainsworth Bearing Top Angle Bushing	20	EA
10.	4112.474.05	3/4 Table Top Retaining Washer	12	EA
11.	4114.175.06	Bearing Rivet	90	EA
12.	4174.106.03	29/32 OD 5/16 ID Ball Bearing	90	EA
13.	4174.208.01	3/4 Ball Bearing 1/4 Bore	10	EA
14.	4323.009.01	Bearing Top Front Bearing Angle	1	EA
15.	4341.009.09	Ainsworth Bearing Top Bearing Angle	1	EA
16.	4542.009.12	Ainsworth Power Top Panel Frame	1	EA
17.	6459.062.01	Military PWR Drive Table Top Panel	1	EA
18.	9543.009.03	Ainsworth Bearing Top Outer Frame	1	EA

TABLE 4-9 PARTS LIST FOR 5736.062.04 BEARING TOP OUTER FRAME ASM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4114.084.01 (4)
4118.526.01 (8)
124.8818.5812
4174.328.03 (8)
4542.082.03
4174.094.03 (9)
4111.084.04 (2)
4181.216.09 (5)
4158.216.01 (5)
4141.526.03 (3)
4144.084.20 (8)
4542.082.05
4448.082.03
4124.009.14 (2)
4117.009.03 (2)
4116.009.01 (4)
4174.094.03 (9)
4120.526.01
4547.080.03
4442.080.03
4111.474.05
4174.474.06
8468.080.01
228.1310.1910
9542.526.01
4113.060.02
4114.060.04
4110.208.02 (2)
4120.060.03
4187.009.04 (2)
4124.060.07
4111.060.04 (2)
4120.060.04
4170.060.01
4113.060.01
8461.060.01
9145.082.01
4547.060.02

MILITARY R-F TABLE LEG ASSEMBLY

FIGURE 4-13 LAYOUT FOR 5736.062.06

SEE ADJACENT FOLD-OUT

FOR **FIGURE 4-13**

	Part Number	Description	Quantity	
1.	121.0632.2417	6-32 X 1-1/2 Round Steel Phlp Screw	2	EA
2.	121.0632.4017	6/32 X 2-1/2 Round Steel Phlps Scrw	4	EA
3.	121.0832.0617	8-32 X 3/8 Round Steel Philps Screw	8	EA
4.	121.1032.0617	10-32 X 3/8 Round Steel Phlps Screw	21	EA
5.	121.1032.1057	10-32 X 5/8 Pan Steel Philips Screw	1	EA
6.	121.1032.1257	10-32 X 3/4 Pan Steel Philips Screw	1	EA
7.	122.1032.02	10-32 Elastic Stop Nut, Nickl Plate	1	EA
8.	122.1518.22	5/16-18 Double Chamferd Stl Hex Nut	6	EA
9.	122.1616.22	3/8-16 Double Chamfered Hex Nut Stl	5	EA
10.	122.2011.0620	5/8-11X39/64H Thin Elastic Stop Nut	1	EA
11.	123.1115.20	11/32ID 11/16OD 1/16T Stl SAE Washr	6	EA
12.	123.1116.20	13/32ID 13/16OD 1/16T Stl SAE Washr	6	EA
13.	123.1306.20	.150ID .375OD .032T Mach Scrw Washr	6	EA
14.	123.1308.20	.170Id .375Od .032T Mach Scrw Washr	4	EA
15.	123.1310.20	.204ID .438OD .032T Mach Scrw Washr	21	EA
16.	123.4062.20	#6 Medium Pattern Split Lockwasher	6	EA
17.	123.4082.20	#8 Medium Pattern Split Lockwasher	8	EA
18.	123.4102.20	#10 Medium Pattern Split Lockwasher	21	EA
19.	123.4152.20	5/16 Medium Pattrn Split Lockwasher	7	EA
20.	123.4162.20	3/8 Medium Pattern Split Lockwasher	5	EA
21.	123.6200.20	5/8 X .046 Internal Tooth Lockwashr	6	EA
22.	124.1420.0821	1/4-20 X 1/2 Sckt Hd St Scrw Cup Pt	2	EA
23.	124.1518.0421	5/16-18 X 1/4 Sckt Hd St Scw Cup Pt	1	EA
24.	124.1518.2421	5/16-18 X 1-1/2 Sckt Hd St Scrw Cup	2	EA
25.	124.6518.1612	5/16-18 X 1 Hex Head Cap Screw	1	EA
26.	124.6616.5642	3/8-16x3-1/2 Socket Head Cap Screw	1	EA

TABLE 4-10 PARTS LIST FOR 5736.062.06 R-F TABLE LEG ASM

	Part Number	Description	Quantity	
27.	124.6624.2042	3/8-24 X 1-1/4 Socket Head Cap Scrw	6	EA
28.	124.6714.1641	7/16-14 X 1 Socket Head Cap Screw	1	EA
29.	124.6813.9945	1/2-13 X 6-1/2 Socket Head Cap Scrw	1	EA
30.	124.7011.2045	5/8-11 X 1-1/4 Socket Head Cap Scrw	1	EA
31.	125.4040.6121	1/16 OD X 3/8 Long .012 Thk Rollpin	4	EA
32.	125.4060.8221	3/32 Od X 1/2 Long .022 Thk Rollpin	2	EA
33.	125.4061.2221	3/32 OD X 3/4 Long .022 Thk Rollpin	2	EA
34.	228.1310.1910	T35 19T 1-1/4 Bore Kwy SS Sprocket	1	EA
35.	4110.208.02	5/16 Circulr Push-On Retaining Ring	2	EA
36.	4111.060.04	Answrth Take Up Chain Guide Bushing	2	EA
37.	4111.084.04	Idler Bearing Bushing	2	EA
38.	4111.474.05	Ainsworth Leg Pivot Bushing	1	EA
39.	4113.060.01	2.7Pd O-Belt Double Groove Pulley	1	EA
40.	4113.060.02	3.4Pd O-Belt Double Groove Pulley	1	EA
41.	4114.060.04	Ainsworth Take-up Chain Guide Shaft	1	EA
42.	4114.084.01	T 35 Chain Connector Pin	4	EA
43.	4116.009.01	Ainsworth Roller Bearing Spacer	4	EA
44.	4117.009.03	Ainsworth Roller Bearing Shaft	2	EA
45.	4118.526.01	203 Bearing 3/8 Shoulder Nut	6	EA
46.	4120.060.03	Fml T-35 Rolr Take Up Chn Connector	1	EA
47.	4120.060.04	Fml T-35 Scrw Take Up Chn Connector	1	EA
48.	4120.526.01	Ainsworth Leg Safety Stop	1	EA
49.	4124.009.14	Ainsworth Roller Bearing Tire	2	EA
50.	4124.060.07	Answrth Take Up Chain Guide Support	1	EA
51.	4124.062.02	MXT 90/15 Tbl Cable Routing Spacer	2	EA
52.	4124.062.03	3/16 X 3/16 X 1-1/8 Key	1	EA

TABLE 4-10 PARTS LIST FOR 5736.062.06 R-F TABLE LEG ASM (continued)

	Part Number	Description	Quantity	
53.	4124.062.04	1/4 X 1/4 X 2 Key	1	EA
54.	4124.084.04	Female T-35 Chain Connector	2	EA
55.	4129.060.19	Answrth Take Up Chain Guide Strip	2	EA
56.	4140.062.03	MXT 90/15 Cable Band Spprt Bracket	4	EA
57.	4140.062.04	MXT 90/15 Cbl Band End Spprt Brckt	2	EA
58.	4140.062.05	Cable Support Band Mounting Plate	2	EA
59.	4141.101.05	CTC High Voltage Clamp Bracket	4	EA
60.	4141.526.03	Ainswrth Table Leg Switch Bracket	3	EA
61.	4144.084.20	Dual 6-32 Speed Nut	6	EA
62.	4144.313.01	High Voltage Cables Two-leggd Clamp	6	EA
63.	4147.062.06	Mil Table Cable Support Band Brckt	1	EA
64.	4150.062.01	Mil-Table Cable Spprt Band Protectr	1	EA
65.	4150.062.02	MXT 90/15 SFD Cable Velcro-Hook-Adh	5	EA
66.	4150.062.03	MXT 90/15 SFD Cable Velcro-Loop	5	EA
67.	4156.216.01	.5" NPT Male Bakelite Bushing	5	EA
68.	4167.009.04	40 Inch O Belt	2	EA
69.	4167.313.03	HV Cable Center Support, Light Grey	6	EA
70.	4170.060.01	11-Pitch 35-3 Triple Chain	1	EA
71.	4174.094.03	201 Double Shield Ball Bearing	9	EA
72.	4174.328.03	Double Shield 203 Ball Bearing	6	EA
73.	4174.474.05	Table Leg Pivot Bearing	1	EA
74.	4175.060.01	7/8 Inch Cable Clamp	3	EA
75.	4175.084.01	3/8 Inch Cable Clamp	1	EA
76.	4175.112.02	5/8 Inch Cable Clamp	2	EA
77.	4181.216.09	SPDT Roller Plunger Switch	5	EA
78.	4270.060.01	219-Pitch 35-3 Triple Chain	1	EA

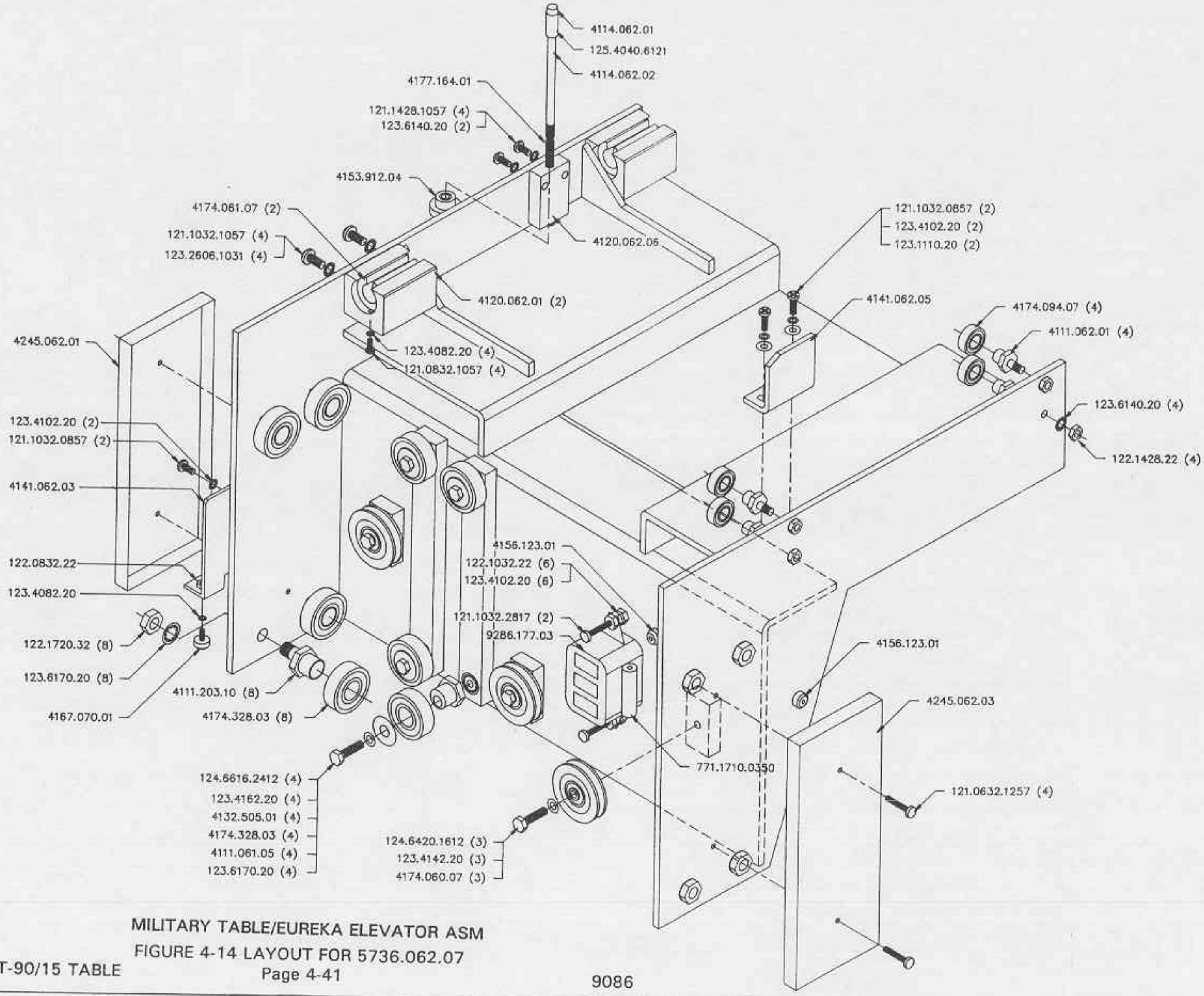
TABLE 4-10 PARTS LIST FOR 5736.062.06 R-F TABLE LEG ASM (continued)

	Part Number	Description	Quantity	
79.	4340.062.01	Mil Table Cable Support Band	1	EA
80.	4442.060.03	Ainsworth Table Leg Cover Support	1	EA
81.	4446.062.03	Table Base Connector Cover	1	EA
82.	4542.062.03	Military Table Leg Cover 3	1	EA
83.	4542.062.05	90/15 Table Base Connector Housing	1	EA
84.	4547.060.02	Ainsworth Leg Cover 1	1	EA
85.	4547.060.03	Ainsworth Leg Cover 2	1	EA
86.	5184.009.01	Up Limit Switch Cable	1	EA
87.	5184.009.02	Down Limit Switch Cable	1	EA
88.	5184.009.03	Horizontal Stop Switch Cable	1	EA
89.	5184.009.04	Center Slow Down Switch Cable	1	EA
90.	5184.009.05	End Slow Down Switch Cable	1	EA
91.	5187.062.23	MXT 90/15 Table Leg Wire Set	1	EA
92.	6461.060.01	1/2Hp 850R 90VDC Intrmtnt Dty Motor	1	EA
93.	6468.060.01	75 To 1 Ohio Gear Reducer	1	EA
94.	737.0322.01	3 Conductor 22 Ga Cable Belden 8443	13	FT
95.	737.0922.01	9 Cnd 22 Awg Shld 300V 80C UL Cable	1	FT
96.	761.1562.10	4-Way Medium Duty Terminal Block	54	EA
97.	761.1590.10	Medium Terminal Block End	2	EA
98.	761.1590.20	Channel Mounting Clamp	4	EA
99.	761.1860.02	60 Term 2 Hole Terminal Channel	2	EA
.00.	769.1407.7151	7 Contact Bulkhead Receptacle	1	EA
.01.	769.2214.4871	14 Contact Bulkhead Receptacle	3	EA
.02.	769.2824.4591	24 Contact Male Bulkhead Receptacle	2	EA
.03.	769.2837.4711	37 Pin Female Bulkhead Receptacle	1	EA
.04.	769.2837.4731	37 Pin Male Bulkhead Receptacle	1	EA

TABLE 4-10 PARTS LIST FOR 5736.062.06 R-F TABLE LEG ASM (continued)

	Part Number	Description	Quantity	
105.	769.3166.1011	16-18 AWG Bulkhead Sockets	55	EA
106.	769.3266.0991	16-18 AWG Bulkhead Pins	34	EA
107.	769.3266.4002	20-22 AWG Bulkhead Connector Pins	46	EA
108.	769.3307.01	AMP Shell Size 17 Strain Relief	1	EA
109.	769.3313.81	Shell Size 23 Strain Relief	2	EA
110.	769.3351.21	Shell Size 23 Large Strain Relief	1	EA
111.	769.3394.55	Shell Size 14 Strain Relief	1	EA
112.	9145.062.01	Military Table Leg Welded Glide Asm	4	EA
113.	9542.526.01	Ainsworth Table Leg Assembly	1	EA

TABLE 4-10 PARTS LIST FOR 5736.062.06 R-F TABLE LEG ASM (continued)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4114.062.02
4177.164.01
121.1428.1057 (4)
123.6140.20 (2)
4153.912.04
4174.061.07 (2)
121.1032.1057 (4)
123.2606.1031 (4)
4120.062.06
4120.062.01 (2)
121.1032.0857 (2)
123.4102.20 (2)
123.1110.20 (2)
4141.062.05
4174.094.07 (4)
4111.062.01 (4)
4245.062.01
123.4082.20 (4)
121.0832.1057 (4)
123.6140.20 (4)
122.1428.22 (4)
123.4102.20 (2)
121.1032.0857 (2)
4141.062.03
122.0832.22
123.4082.20
4156.123.01
122.1032.22 (6)
123.4102.20 (6)
121.1032.2817 (2)
9286.177.03
122.1720.32 (8)
123.6170.20 (8)
4111.203.10 (8)
4167.070.01
4174.328.03 (8)
4156.123.01
4245.062.03
771.1710.0350
124.6616.2412 (4)
123.4162.20 (4)
4132.505.01 (4)
4174.328.03 (4)
4111.061.05 (4)
123.6170.20 (4)
121.0632.1257 (4)
124.6420.1612 (3)
123.4142.20 (3)
4174.060.07 (3)

MILITARY TABLE/EUREKA ELEVATOR ASM

FIGURE 4-14 LAYOUT FOR 5736.062.07

SEE ADJACENT FOLD-OUT

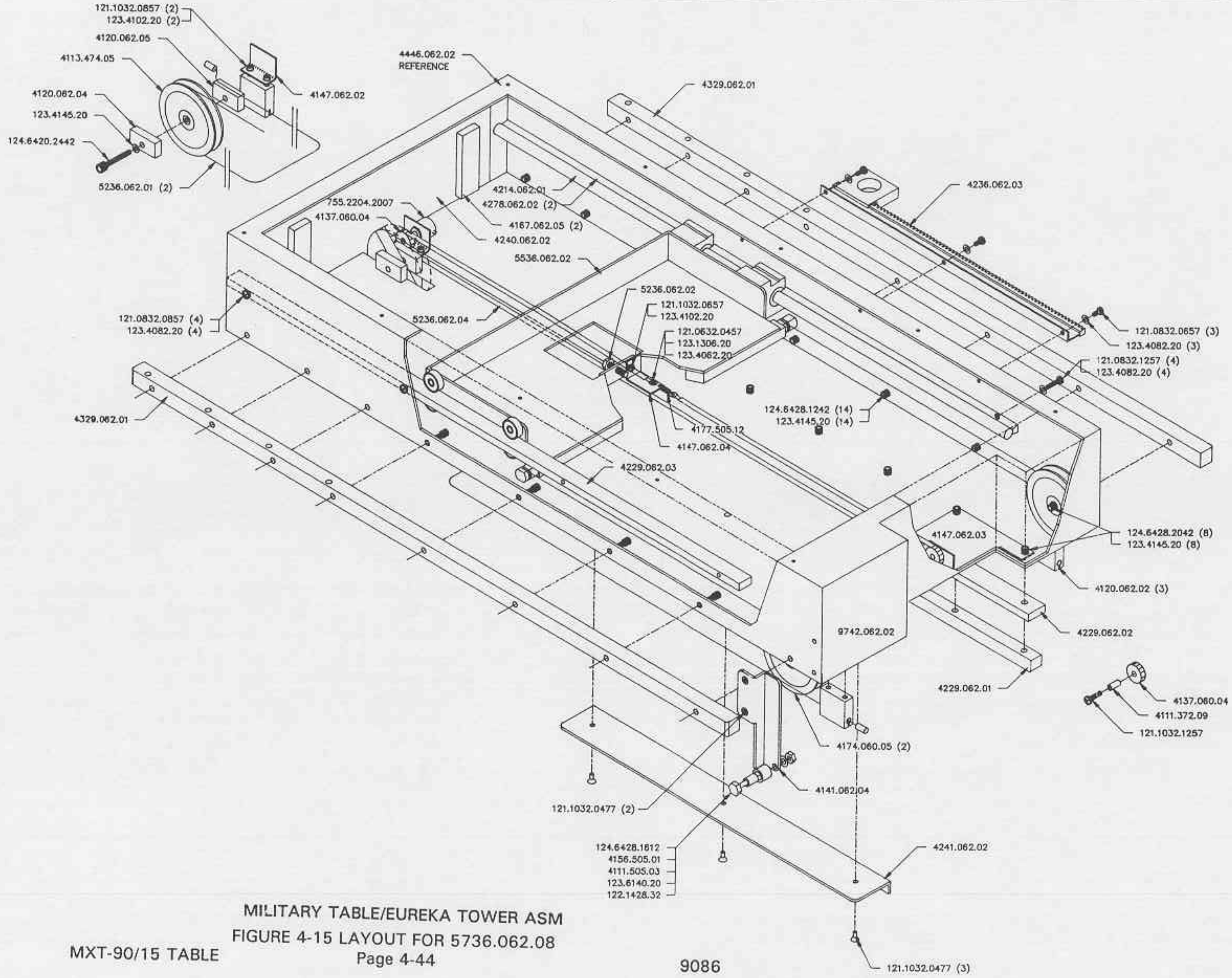
FOR **FIGURE 4-14**

	Part Number	Description	Quantity
1.	121.0632.1257	6-32 X 3/4 Pan Steel Phillips Screw	4 EA
2.	121.0832.1057	8-32 X 5/8 Pan Steel Phillips Screw	4 EA
3.	121.1032.0857	10-32 X 1/2 Pan Steel Philips Screw	2 EA
4.	121.1032.1057	10-32 X 5/8 Pan Steel Philips Screw	4 EA
5.	121.1032.2817	10-32 X 1-3/4 Round Stl Phlps Screw	2 EA
6.	121.1428.1057	1/4-28 X 5/8 Pan Steel Philps Screw	4 EA
7.	122.0832.22	8-32 Double Chamfered Steel Hex Nut	1 EA
8.	122.1032.22	10-32 Double Chamfered Hex Nut Stl	6 EA
9.	122.1428.22	1/4-28 Double Chamfered Stl Hex Nut	4 EA
10.	122.1720.32	7/16-20 Hex Steel Jam Nut	8 EA
11.	123.1110.20	7/32ID 1/2OD 3/64Thk Stl SAE Washer	2 EA
12.	123.2606.1031	#6 5/16 OD White Flat Nylon Washer	4 EA
13.	123.4082.20	#8 Medium Pattern Split Lockwasher	4 EA
14.	123.4102.20	#10 Medium Pattern Split Lockwasher	8 EA
15.	123.4142.20	1/4 Medium Pattern Split Lockwasher	3 EA
16.	123.4162.20	3/8 Medium Pattern Split Lockwasher	4 EA
17.	123.6140.20	1/4 Internal Tooth Steel Lockwasher	8 EA
18.	123.6170.20	7/16 Internal Tooth Steel Lockwashr	12 EA
19.	124.6420.1612	1/4-20 X 1 Hex Head Cap Screw	3 EA
20.	124.6616.2412	3/8-16 X 1-1/2 Hex Head Cap Screw	4 EA
21.	125.4040.6121	1/16 OD X 3/8 Long .012 Thk Rollpin	1 EA
22.	4111.061.05	203 Bearing .25 Head Ecc Bushing	4 EA
23.	4111.062.01	.906 Brng .187 Hd 1/4-28 Stud Ecc	4 EA
24.	4111.203.10	Eccentric Bushing (203-BB)	8 EA
25.	4114.062.01	Eureka Elevator Plunger Tip	1 EA
26.	4114.062.02	Eureka Elevator Plunger Shaft	1 EA

TABLE 4-11 PARTS LIST FOR 5736.062.07 TABLE/SFD ELEVATOR ASM

	Part Number	Description	Quantity	
27.	4120.062.01	Super-10-Opn Ball Bushing Housing	2	EA
28.	4120.062.06	Eureka Elevator Plunger Housing	1	EA
29.	4132.505.01	.39 ID X 1.0 OD X Ga Stl Washer	4	EA
30.	4141.062.03	Myelographic Stop Bumper Bracket	1	EA
31.	4141.062.05	9.5" SFD Park Switch Actuator	1	EA
32.	4153.912.04	241 Dimco 1/4-20 Blk Knurled Knob	1	EA
33.	4156.123.01	.25 Strain Relief Bushing	2	EA
34.	4167.070.01	8-32 X 3/8 Stud Rubber Bumper	1	EA
35.	4174.060.07	2" X 1/4 Alum Pulley Ball Bearing	3	EA
36.	4174.061.07	Thomson Super-10 Opn Ball Bushing	2	EA
37.	4174.094.07	29/32 OD 7/16 ID Ball Bearing	4	EA
38.	4174.328.03	Double Shield 203 Ball Bearing	12	EA
39.	4177.164.01	Cassette Plunger Spring	1	EA
40.	4245.062.01	9.5" SFD Elevator Plain Cover	1	EA
41.	4245.062.03	9.5" SFD Elevator Notched Cover	1	EA
42.	4742.062.01	Eureka Spot Device Tower Elevator	1	EA
43.	771.1710.0350	100 Mfd 50 Volt Electyc Capacitor	1	EA
44.	9286.177.03	28 Volt Magnet	1	EA

TABLE 4-11 PARTS LIST FOR 5736.062.07 TABLE/SFD ELEVATOR ASM (continued)


121.1032.0857 (2)
123.4102.20 (2)
4120.062.05
4113.474.05
4120.062.04
123.4145.20
124.6420.2442
5236.062.01 (2)
4147.062.02
4446.062.02
REFERENCE
4329.062.01
4236.062.03
755.2204.2007
4137.060.04
4214.062.01
4278.062.02 (2)
4167.062.05 (2)
4240.062.02
5536.062.02
5236.062.02
121.1032.0657
123.4102.20
121.0632.0457
123.1306.20
123.4062.20
121.0832.0857 (4)
123.4082.20 (4)
5236.062.04
121.0832.0657 (3)
123.4082.20 (3)
121.0832.1257 (4)
123.4082.20 (4)
4329.062.01
124.6428.1242 (14)
123.4145.20 (14)
4177.505.12
4147.062.04
4229.062.03
124.6428.2042 (8)
123.4145.20 (8)
4147.062.03
4120.062.02 (3)
9742.062.02
4229.062.02
4229.062.01
4137.060.04
4111.372.09
121.1032.1257
4174.060.05 (2)
4141.062.04
121.1032.0477 (2)
124.6428.1612
4156.505.01
4111.505.03
123.6140.20
122.1428.32
4241.062.02
121.1032.0477 (3)

MILITARY TABLE/EUREKA TOWER ASM

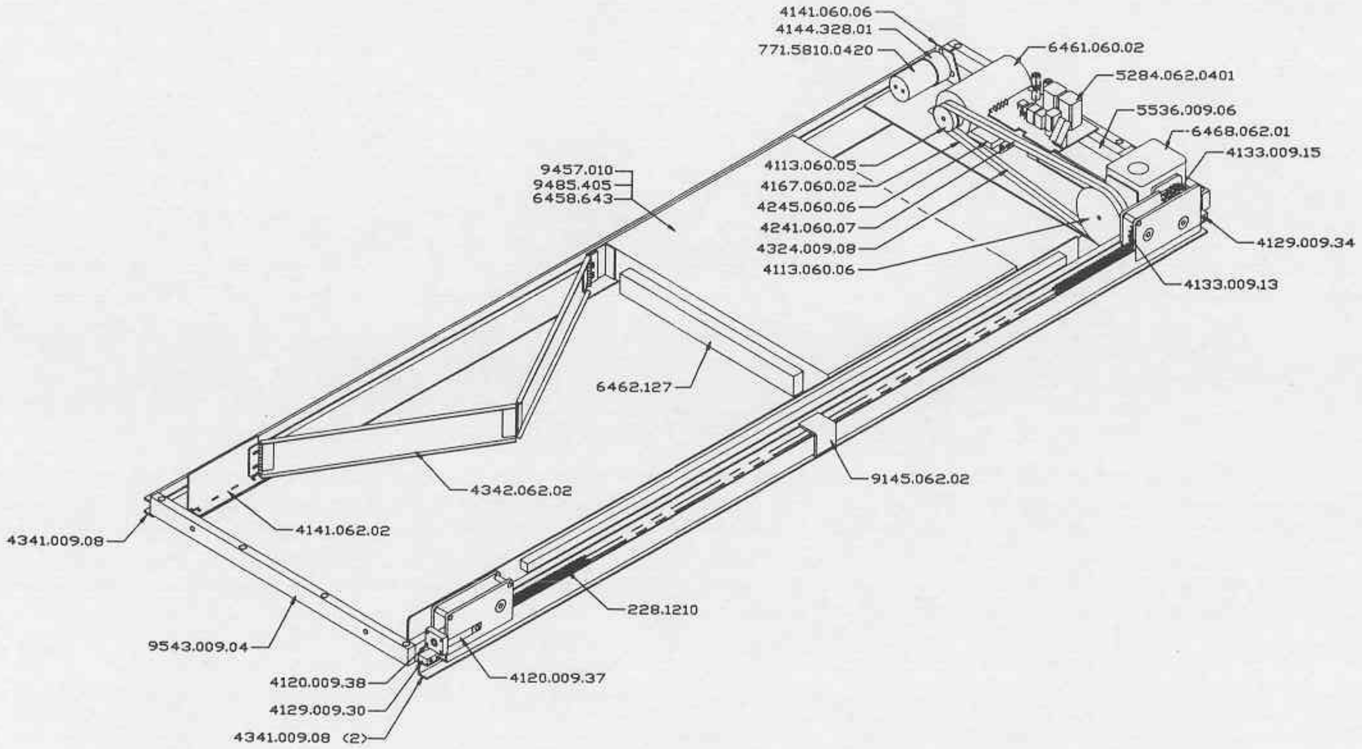
FIGURE 4-15 LAYOUT FOR 5736.062.08

	Part Number	Description	Quantity	
1.	121.0632.0457	6-32 X 1/4 Pan Steel Phillips Screw	1	EA
2.	121.0832.0657	8-32 X 3/8 Pan Steel Phillips Screw	16	EA
3.	121.0832.1257	8-32 X 3/4 Pan Steel Phillips Screw	4	EA
4.	121.1032.0477	10-32 X 1/4 Flat Undercut Stl Screw	5	EA
5.	121.1032.0657	10-32 X 3/8 Pan Steel Philips Screw	1	EA
6.	121.1032.0857	10-32 X 1/2 Pan Steel Philips Screw	6	EA
7.	121.1032.1257	10-32 X 3/4 Pan Steel Philips Screw	1	EA
8.	122.1428.32	1/4-28 Hex Steel Jam Nut Nkl Plt	1	EA
9.	123.1306.20	.150ID .375OD .032T Mach Scrw Washr	1	EA
10.	123.4062.20	#6 Medium Pattern Split Lockwasher	1	EA
11.	123.4082.20	#8 Medium Pattern Split Lockwasher	28	EA
12.	123.4102.20	#10 Medium Pattern Split Lockwasher	8	EA
13.	123.4145.20	1/4 Hi-Collar Split Lockwasher	23	EA
14.	123.6140.20	1/4 Internal Tooth Steel Lockwasher	1	EA
15.	124.0832.0871	8-32x1/2 Bttn Sckt Hd Cap Stl Scrw	4	EA
16.	124.0832.1072	8-32x5/8 Bttn Sckt Hd Cap Stl Screw	4	EA
17.	124.6420.2442	1/4-20 X 1-1/2 Socket Head Cap Scrw	1	EA
18.	124.6428.1242	1/4-28 X 3/4 Socket Head Cap Screw	14	EA
19.	124.6428.1612	1/4-28 X 1 Hex Head Cap Screw	1	EA
20.	124.6428.2042	1/4-28 X 1-1/4 Socket Head Cap Scrw	8	EA
21.	4111.372.09	Prescott II Hght Sens Idler Bushing	1	EA
22.	4111.505.03	Spot Device Parking Roller Bushing	1	EA
23.	4113.474.05	3-5/16 X 1/4 Aluminum Roller	1	EA
24.	4120.062.02	Eureka S/D Tower Cable Anchor	3	EA
25.	4120.062.04	.257 Hole Tower Lower Pulley Block	1	EA
26.	4120.062.05	1/4-20 Tap Tower Lower Pulley Block	1	EA

TABLE 4-12 PARTS LIST FOR 5736.062.08 TABLE/SFD TOWER ASM

	Part Number	Description	Quantity	
27.	4137.060.04	14G 1/5 P Al Positive Drive Pulley	2	EA
28.	4141.062.04	9.5 Spot Device Parking Bracket	1	EA
29.	4147.062.02	Height Sensor Pot Mounting Bracket	1	EA
30.	4147.062.03	Height Sensor Idler Bracket	1	EA
31.	4147.062.04	Height Sensor Belt Attachment Brckt	1	EA
32.	4156.505.01	Spot Device Parking Nylon Roller	1	EA
33.	4167.062.05	7/16 X 3/4 X 4 Sponge Rubber Bumper	2	EA
34.	4174.060.05	3-1/2 x1/4 Alum Pulley Ball Bearing	2	EA
35.	4177.505.12	.180 OD X 1 X .024 Wire Extn Spring	1	EA
36.	4214.062.01	Spot Device Tower Cwt Guide Rod	1	EA
37.	4229.062.01	Eureka Spot Device Tower Frnt Track	1	EA
38.	4229.062.02	Eureka Tower Front Track Spacer	1	EA
39.	4229.062.03	Spot Device Tower Cwt Guide Track	1	EA
40.	4236.062.03	Myelographic Stop And Rack Assembly	1	EA
41.	4241.062.02	Long Tower Magnetic Lock Strip	1	EA
42.	4278.062.02	Spot Device Tower Guide Rod Support	2	EA
43.	4329.062.01	Eureka Spot Device Tower Side Track	2	EA
44.	4446.062.02	9.5 Spot Device Tower Rear Cover	1	EA
45.	5236.062.01	Mil Table/Eureka Main Cwt Cable	2	EA
46.	5236.062.02	Mil Table/Eureka Return Cwt Cable	1	EA
47.	5236.062.04	Height Sensor Belt Assembly	1	EA
48.	5536.062.02	Mil Table/Eureka Tower Cwt Asm	1	EA
49.	755.2204.2007	.2K 2W WW 10T Spectrol Mod. 534 Pot	1	EA
50.	9742.062.02	Eureka Spot Device Tower Weldment	1	EA

TABLE 4-12 PARTS LIST FOR 5736.062.08 TABLE/SFD TOWER ASM (continued)


4141.060.06
4144.328.01
771.5810.0420
6461.060.02
5284.062.0401
5536.009.06
6468.062.01
4133.009.15
9457.010
9485.405
6458.643
4113.060.05
4167.060.02
4245.060.06
4241.060.07
4324.009.08
4113.060.06
4129.009.34
4133.009.13
6462.127
4342.062.02
9145.062.02
4141.062.02
4341.009.08
228.1210
9543.009.04
4120.009.38
4120.009.37
4129.009.30
4341.009.08 (2)

MILITARY BEARING TOP INNER FRAME ASM

FIGURE 4-16 LAYOUT FOR 5736.062.09

	Part Number	Description	Quantity	
1.	121.0632.0457	6-32 X 1/4 Pan Steel Phillips Screw	3	EA
2.	121.0832.0357	8-32 X 3/16 Pan Steel Phillps Screw	13	EA
3.	121.0832.0657	8-32 X 3/8 Pan Steel Phillips Screw	3	EA
4.	121.0832.0857	8-32 X 1/2 Pan Steel Phillips Screw	6	EA
5.	121.1032.0477	10-32 X 1/4 Flat Undercut Stl Screw	2	EA
6.	121.1032.0657	10-32 X 3/8 Pan Steel Philips Screw	28	EA
7.	121.1032.0857	10-32 X 1/2 Pan Steel Philips Screw	20	EA
8.	121.1032.0877	10-32 X 1/2 Flat Undercut Stl Screw	7	EA
9.	121.1032.1057	10-32 X 5/8 Pan Steel Philips Screw	18	EA
10.	121.1032.1227	10-32 X 3/4 Flat Steel Philps Screw	1	EA
11.	121.1032.1657	10-32 X 1 Pan Steel Philips Screw	2	EA
12.	121.1032.2057	10-32 X 1-1/4 Pan Steel Phlps Screw	2	EA
13.	122.1420.22	1/4-20 Double Chamfered Stl Hex Nut	8	EA
14.	122.1518.22	5/16-18 Double Chamferd Stl Hex Nut	4	EA
15.	123.1110.20	7/32ID 1/2OD 3/64Thk Stl SAE Washer	30	EA
16.	123.1114.20	9/32ID 5/8OD 1/16Thk Stl SAE Washer	8	EA
17.	123.1115.20	11/32ID 11/16OD 1/16T Stl SAE Washr	8	EA
18.	123.1115.50	11/32ID 11/16OD 1/16T Stl SAE Washr	4	EA
19.	123.1308.20	.170Id .3750d .032T Mach Scrw Washr	10	EA
20.	123.4062.20	#6 Medium Pattern Split Lockwasher	3	EA
21.	123.4082.20	#8 Medium Pattern Split Lockwasher	4	EA
22.	123.4102.20	#10 Medium Pattern Split Lockwasher	17	EA
23.	123.4142.20	1/4 Medium Pattern Split Lockwasher	8	EA
24.	123.4152.20	5/16 Medium Pattrn Split Lockwasher	4	EA
25.	123.6100.20	#10 Internal Tooth Steel Lockwashr	28	EA
26.	123.6140.20	1/4 Internal Tooth Steel Lockwasher	4	EA

TABLE 4-13 PARTS LIST FOR 5736.062.09 BEARING TOP INNER FRAME ASM

	Part Number	Description	Quantity	
27.	123.7500.0137	1.37 Internal Retaining Ring	8	EA
28.	124.1420.0821	1/4-20 X 1/2 Sckt Hd St Scrw Cup Pt	2	EA
29.	124.1518.0621	5/16-18 X 3/8 Sckt Hd St Scw Cup Pt	1	EA
30.	124.6524.1242	5/16-24 X 3/4 Socket Head Cap Screw	3	EA
31.	124.6624.2042	3/8-24 X 1-1/4 Socket Head Cap Scrw	1	EA
32.	124.6624.2442	3/8-24 X 1-1/2 Socket Head Cap Scrw	4	EA
33.	125.4061.2221	3/32 OD X 3/4 Long .022 Thk Rollpin	1	EA
34.	125.4081.6281	1/8 Od X 1 Long .028 Thick Rollpin	4	EA
35.	125.4101.8321	5/32 Od X 1-1/8 L .032 Thk Rollpin	4	EA
36.	125.4161.8481	1/4 Od X 1-1/8 L .048 Thick Rollpin	4	EA
37.	127.1042.0061	1/4-20 X 3/4 Carriage Bolt	8	EA
38.	228.1210.	#35 Double width 3/8 pitch chain	13	FT
39.	228.1524.0201	24P 20T Steel Gear Rollpin	1	EA
40.	4111.009.15	Ainsworth Idler Sprocket Spacer	3	EA
41.	4111.009.16	Ainswr Idler Adjust Sprocket Spacer	4	EA
42.	4111.009.17	Ainsworth Adjust Sprocket Spacer	1	EA
43.	4113.060.05	1.8 Pd O-Belt Double Groove Pulley	1	EA
44.	4113.060.06	4.5Pd O-Belt Double Groove Pulley	1	EA
45.	4120.009.37	Ainsworth Adjust Sprocket Block	1	EA
46.	4120.009.38	Ainsworth Adjust Screw Block	1	EA
47.	4120.062.03	Grid Cabinet Bumper Stop Block	1	EA
48.	4129.009.30	Bearng Channl Rear Support Head End	1	EA
49.	4129.009.31	Bearing Channel Front Support	2	EA
50.	4129.009.34	Bearng Channl Rear Support Foot End	1	EA
51.	4129.060.22	Answrth Pwr Top Gear Reducer Lifter	1	EA
52.	4133.009.10	35 2 Connecting Link	2	EA

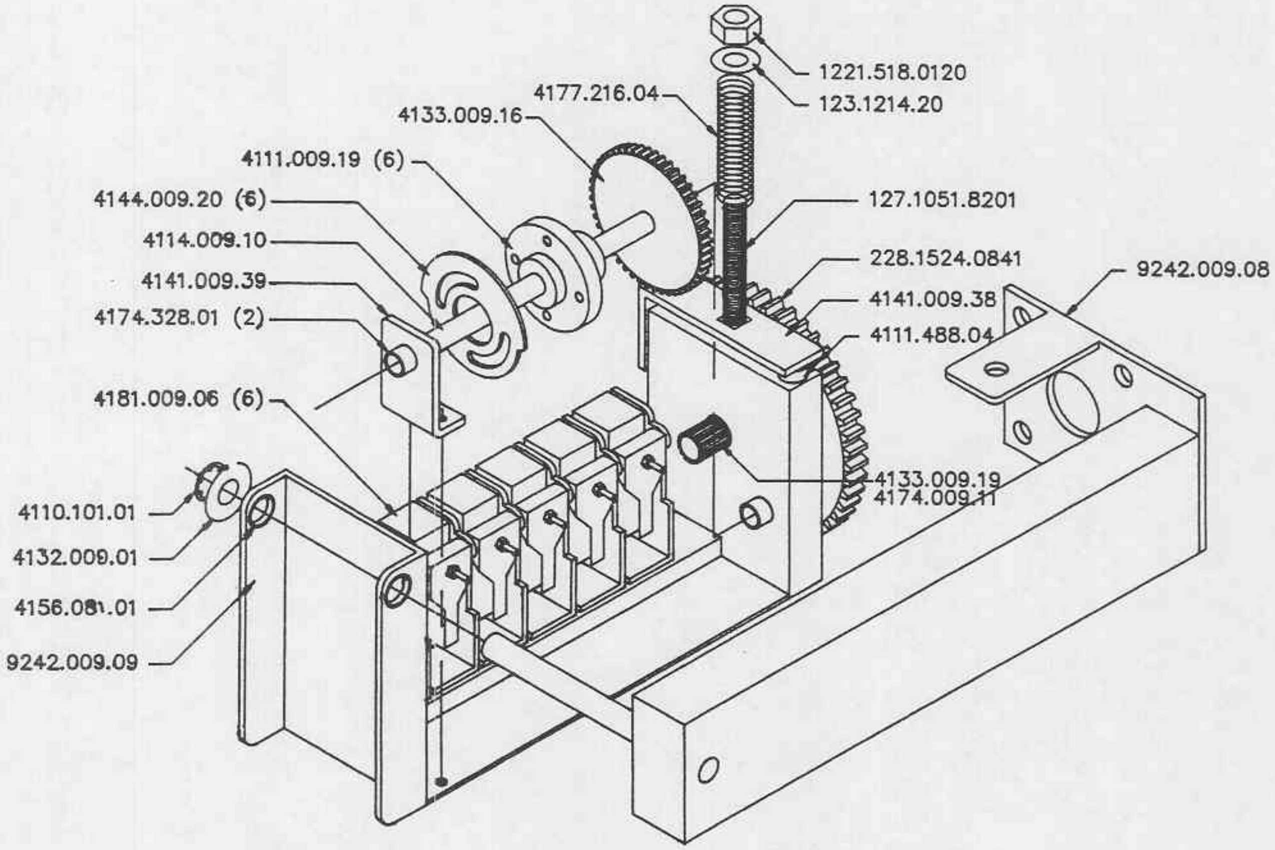
TABLE 4-13 P/L FOR 5736.062.09 BEARING TOP INNER FRAME ASM (continued)

	Part Number	Description	Quantity	
53.	4133.009.13	18T Double Idler Sprocket	4	EA
54.	4133.009.15	Ainsworth Top Drive Sprocket	1	EA
55.	4136.873.01	1/4-20Thd Hand Retractable Plunger	1	EA
56.	4141.060.06	Power Top Capacitor Mtg Clamp Sprt	1	EA
57.	4141.062.02	Military Table Slot Closure Bracket	1	EA
58.	4141.062.09	Grid Cabinet Lock Switch Bracket	1	EA
59.	4144.328.01	Crtndn 2" Motor Capacitor Mounting	1	EA
60.	4167.060.02	43 Inch O-Section V-Belt	2	EA
61.	4167.062.06	.30"H x .81SQ Self Adhessive Bumper	1	EA
62.	4167.070.01	8-32 X 3/8 Stud Rubber Bumper	1	EA
63.	4174.009.02	202 Double Shield Ball Bearing	4	EA
64.	4189.085.03	28 Volt .04 Amp Mid Flange Bulb	1	EA
65.	4229.873.07	Mil. Shippng Fixture Grid Cab. Lock	1	EA
66.	4241.060.02	Bodine 968L Motor Base Mount Brkt	1	EA
67.	4241.060.03	Power Top Sub Panel Head End Keeper	1	EA
68.	4241.060.04	Power Top Sub Panel Foot End Keeper	1	EA
69.	4245.060.06	Pwr Top Adjustable Motor Base Brkt	1	EA
70.	4324.009.07	Bearing Top Bearing Bar	1	EA
71.	4324.009.08	Bearing Top Bucky Roller Bar	1	EA
72.	4340.009.06	Ainsworth Bearing Top Bearing Strip	1	EA
73.	4341.009.08	Answrth Bearing Top Bearing Channel	2	EA
74.	4341.060.01	Power Top Sub Panel 1 Side Keeper	2	EA
75.	4341.060.02	Power Top Sub Panel 2 Side Keeper	2	EA
76.	4342.062.02	Military Table Bucky Slot Closure	1	EA
77.	5236.009.10	Td Right Front Bucky Bracket Asm	1	EA
78.	5236.062.05	Ion/Grid Cabinet Rt Rr Bracket Asm	1	EA

TABLE 4-13 P/L FOR 5736.062.09 BEARING TOP INNER FRAME ASM (continued)

	Part Number	Description	Quantity	
79.	5236.062.07	Military Left Front Bky Bracket Asm	1	EA
80.	5284.062.0401	MXT 90/15 Power Top Long. Drive PCB	1	EA
81.	5436.009.07	Td Left Rear Bucky Bracket Asm	1	EA
82.	5536.009.06	Top Drive Control Switch Assembly	1	EA
83.	6459.328.03	Power Drive Table Inner Panel	1	EA
84.	6461.060.02	1/8 Hp PM 2500 RPM 130 VDC Motor	1	EA
85.	6468.062.01	66-1 Power Top Gear Reducer	1	EA
86.	717.0501.10	1-NO/NC Mom Rectangle Pushbutton	1	EA
87.	717.0503.36	Clear Rectangle Pushbutton Lens Set	1	EA
88.	752.2506.6250	25K 5W 5% Fixed WW Low T/C Resistor	1	EA
89.	771.5810.1420	1000 Mfd 200 Volt Elctyc Capacitor	1	EA
90.	9145.062.02	Military Chain Anchor Assembly	1	EA
91.	9543.009.04	Ainsworth Bearing Top Inner Frame	1	EA

TABLE 4-13 P/L FOR 5736.062.09 BEARING TOP INNER FRAME ASM (continued)


1221.518.0120
123.1214.20
4177.216.04
4133.009.16
4111.009.19 (6)
4144.009.20 (6)
4114.009.10
4141.009.39
4174.328.01 (2)
4181.009.06 (6)
4110.101.01
4132.009.01
4156.081.01
9242.009.09
127.1051.8201
228.1524.0841
9242.009.08
4141.009.38
4111.488.04
4133.009.19
4174.009.11

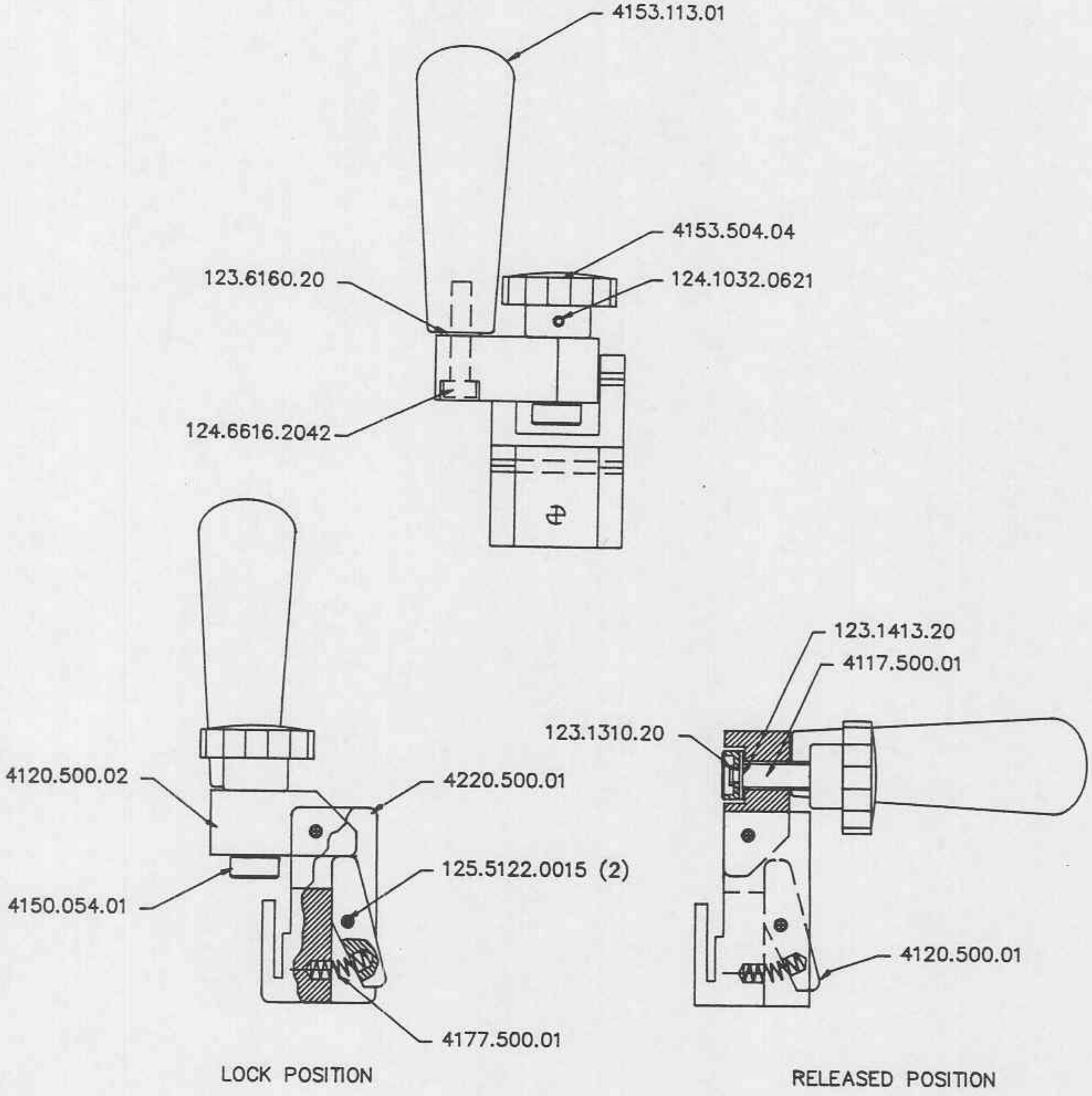
TOP DRIVE CONTROL SWITCH ASM
FIGURE 4-17 LAYOUT FOR 5536.009.06

	Part Number	Description	Quantity	
1.	121.0632.0557	6-32 X 5/16 Pan Steel Philips Screw	14	EA
2.	122.1518.0120	5/16-18 Light Weight Stop Nut	1	EA
3.	123.1216.20	7/16Id 1"Od 5/64T Stl Wrght Washer	2	EA
4.	123.1306.20	.150ID .375OD .032T Mach Scrw Washr	14	EA
5.	123.1308.20	.170Id .375Od .032T Mach Scrw Washr	6	EA
6.	123.4062.20	#6 Medium Pattern Split Lockwasher	14	EA
7.	124.5832.0612	8-32 X 3/8 Hex Head Cap Screw	6	EA
8.	127.1051.8201	5/16-18 X 2-1/2 Carriage Bolt	1	EA
9.	228.1524.0841	Brass Gear With 3/32 Hub Hole	1	EA
10.	4110.101.01	3/8 Inch External Retaining Ring	1	EA
11.	4111.009.19	Ainsworth Top Drive Control Cam Hub	6	EA
12.	4111.488.04	Stafford Guide Spacer	1	EA
13.	4114.009.10	Ainsworth Top Drive Control Shaft	1	EA
14.	4132.009.01	..380 ID Thrust Washer	1	EA
15.	4133.009.16	Limit Switch Gear	1	EA
16.	4133.009.19	32P 15T Top Drive Pin	1	EA
17.	4141.009.38	Ainsworth Top Drive Control Bracket	1	EA
18.	4141.009.39	Top Drive Control Shaft Bracket	1	EA
19.	4144.009.20	Ainsworth Top Drive Control Cam	6	EA
20.	4156.081.01	Compere 3/8 X 7/16 Nyliner Bearing	1	EA
21.	4174.009.11	3/8 X 1/2 X 3/4 Flanged Bearing	1	EA
22.	4174.328.01	5/16 X 3/8 X 3/8 Flanged Bearing	2	EA
23.	4177.216.04	Bucky Lock Spring	1	EA
24.	4179.062.21	MXT 90/15 Tbl Top Installation Tag	1	EA
25.	4181.009.06	Limit Switch Assembly	6	EA
26.	5187.062.22	MXT 90/15 Table Top Limit Sw Cable	1	EA

TABLE 4-14 PARTS LIST FOR 5536.009.06 TOP DRIVE CONTROL SWITCH ASM

	Part Number	Description	Quantity
27.	9242.009.08	Top Drive Reducer Switch Bracket	1 EA
28.	9242.009.09	Top Drive Control Switch Bracket	1 EA

TABLE 4-14 P/L FOR 5536.009.06 TOP DRIVE CONTROL SW ASM (continued)


4153.113.01
4153.504.04
123.6160.20
124.1032.0621
124.6616.2042
123.1413.20
4117.500.01
123.1310.20
4120.500.02
4220.500.01
125.5122.0015 (2)
4150.054.01
4120.500.01
4177.500.01

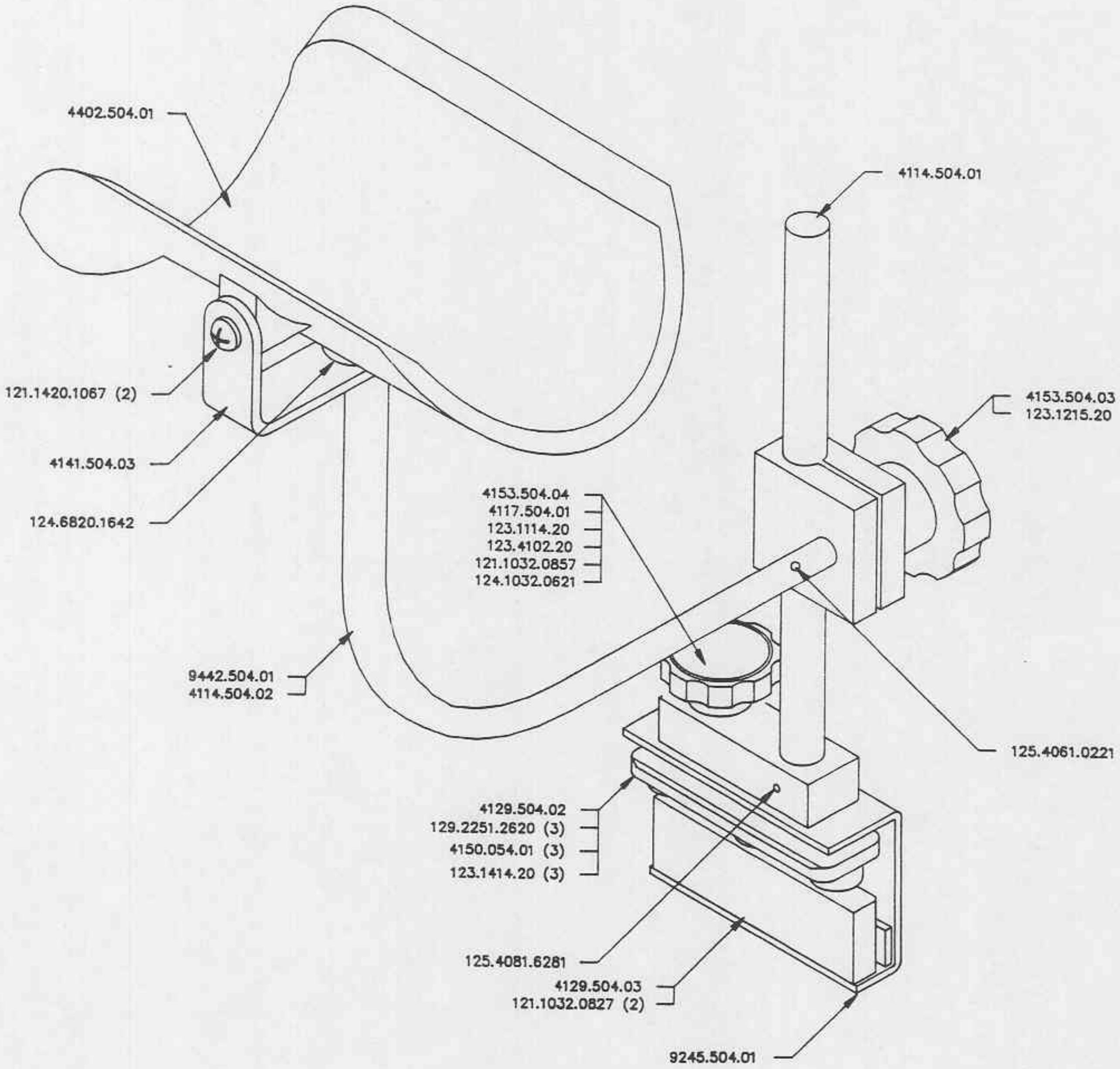
LOCK POSITION

RELEASED POSITION

PATIENT HANDGRIP ASSEMBLY
FIGURE 4-18 LAYOUT FOR 5236.500.02

	Part Number	Description	Quantity
1.	123.1310.20	.204ID .438OD .032T Mach Scrw Washr	1 EA
2.	123.1413.20	17/64I 1/2Od 1/32T Stl Elect.Washer	1 EA
3.	123.6160.20	3/8 Internal Tooth Steel Lockwasher	1 EA
4.	124.1032.0621	10-32 X 3/8 Sckt Hd Set Scrw Cup Pt	1 EA
5.	124.6616.2042	3/8-16 X 1-1/4 Socket Head Cap Scrw	1 EA
6.	125.5122.0015	3/16 X 2 Type C Driv Lok Pin	2 EA
7.	4117.500.01	Patient Hand Grip Lock Screw	1 EA
8.	4120.500.01	Patient Hand Grip Release Latch	1 EA
9.	4120.500.02	Patient Hand Grip Handle Support	1 EA
10.	4150.054.01	Nylon Roller	1 EA
11.	4153.113.01	Smooth Tapered Grey Handle	1 EA
12.	4153.504.04	Reid DK-23 3/8 D Black Fluted Knob	1 EA
13.	4177.500.01	Patient Hand Grip Release Spring	1 EA
14.	4220.500.01	Patient Hand Grip Table Support	1 EA

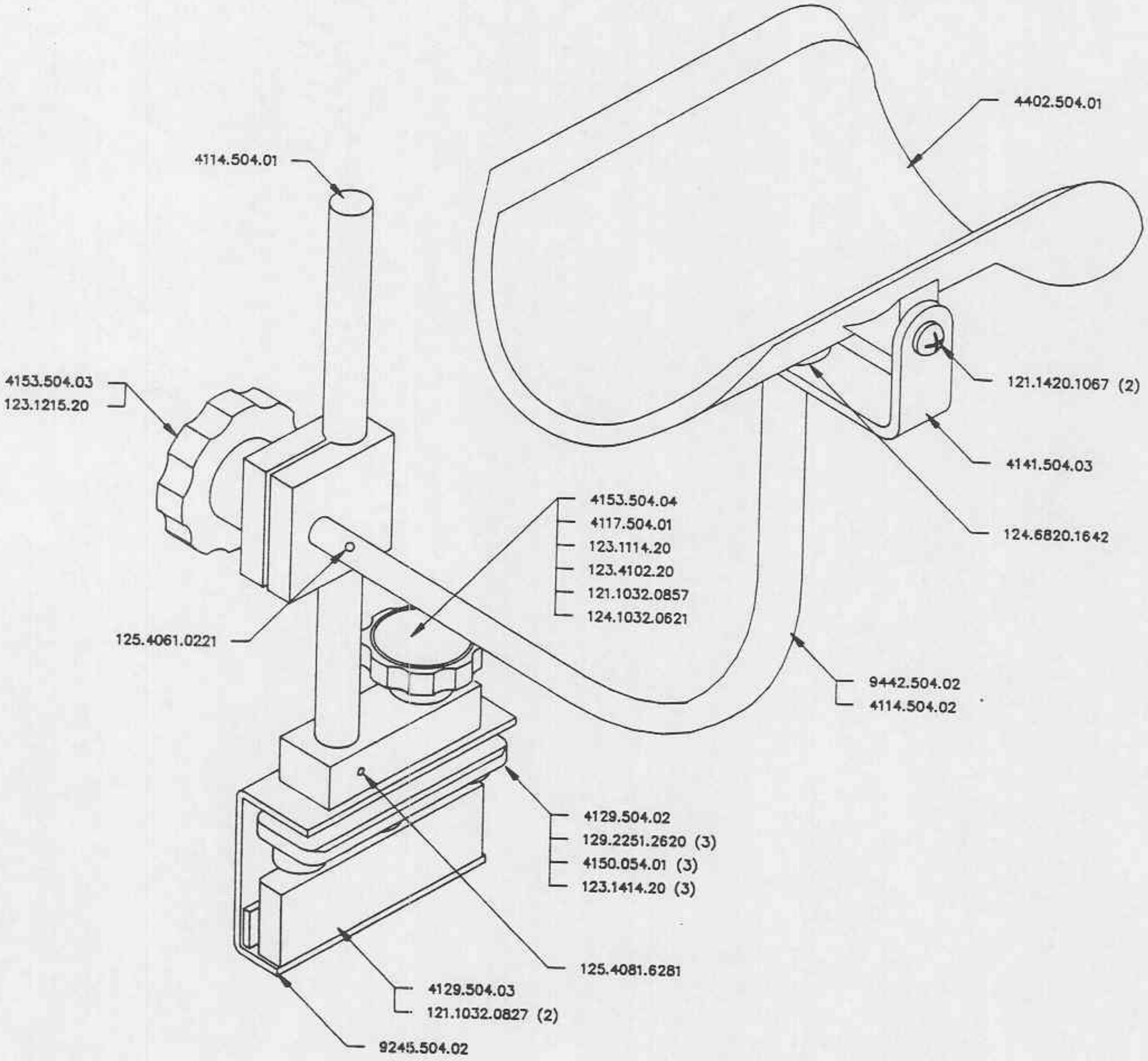
TABLE 4-15 PARTS LIST FOR 5236.500.02 PATIENT HANDGRIP


4402.504.01
4114.504.01
121.1420.1067 (2)
4153.504.03
123.1215.20
4141.504.03
124.6820.1642
4153.504.04
4117.504.01
123.1114.20
123.4102.20
121.1032.0857
124.1032.0621
9442.504.01
4114.504.02
125.4061.0221
4129.504.02
129.2251.2620 (3)
4150.054.01 (3)
123.1414.20 (3)
125.4081.6281
4129.504.03
121.1032.0827 (2)
9245.504.01

UROLOGICAL RIGHT-HAND KNEE CRUTCH ASM
FIGURE 4-19 LAYOUT FOR 5436.504.02

	Part Number	Description	Quantity	
1.	121.1032.0827	10-32 X 1/2 Flat Steel Philps Screw	2	EA
2.	121.1032.0857	10-32 X 1/2 Pan Steel Philips Screw	1	EA
3.	121.1420.1067	1/4-20 X 5/8 Truss Steel Phlp Screw	2	EA
4.	123.1114.20	9/32ID 5/8OD 1/16Thk Stl SAE Washer	1	EA
5.	123.1215.20	3/8ID 7/8OD 5/64T Stl Wrght Washer	1	EA
6.	123.1414.20	17/64I 1/20d 1/16T Stl Elect.Washer	3	EA
7.	123.4102.20	#10 Medium Pattern Split Lockwasher	1	EA
8.	124.1032.0621	10-32 X 3/8 Sckt Hd Set Scrw Cup Pt	1	EA
9.	124.6820.1642	1/2-20 X 1 Socket Head Cap Screw	1	EA
10.	125.4061.0221	3/32 Od x 5/8 Long .022 Thk Rollpin	1	EA
11.	125.4081.6281	1/8 Od X 1 Long .028 Thick Rollpin	1	EA
12.	129.2251.2620	1/4 D X .38 Lth X .44Hd Rivet	3	EA
13.	4114.504.01	Knee Crutch Leg Support Shaft	1	EA
14.	4114.504.02	Knee Crutch Clamp Support Shaft	1	EA
15.	4117.504.01	Knee Crutch Table Top Clamp Screw	1	EA
16.	4129.504.02	Knee Crutch Compression Bar	1	EA
17.	4129.504.03	Knee Crutch Locking Strip	1	EA
18.	4141.504.03	Knee Crutch Leg Support Swivel Yoke	1	EA
19.	4150.054.01	Nylon Roller	3	EA
20.	4153.504.03	Reid DK-3 3/8-16 Black Fluted Knob	1	EA
21.	4153.504.04	Reid DK-23 3/8 D Black Fluted Knob	1	EA
22.	4153.504.05	Leg Support Shaft Protective Cap	1	EA
23.	4402.504.01	Knee Crutch Leg Support	1	EA
24.	9245.504.01	Power Top RH Knee Crutch Support	1	EA
25.	9442.504.01	RH Knee Crutch Support Clamp	1	EA

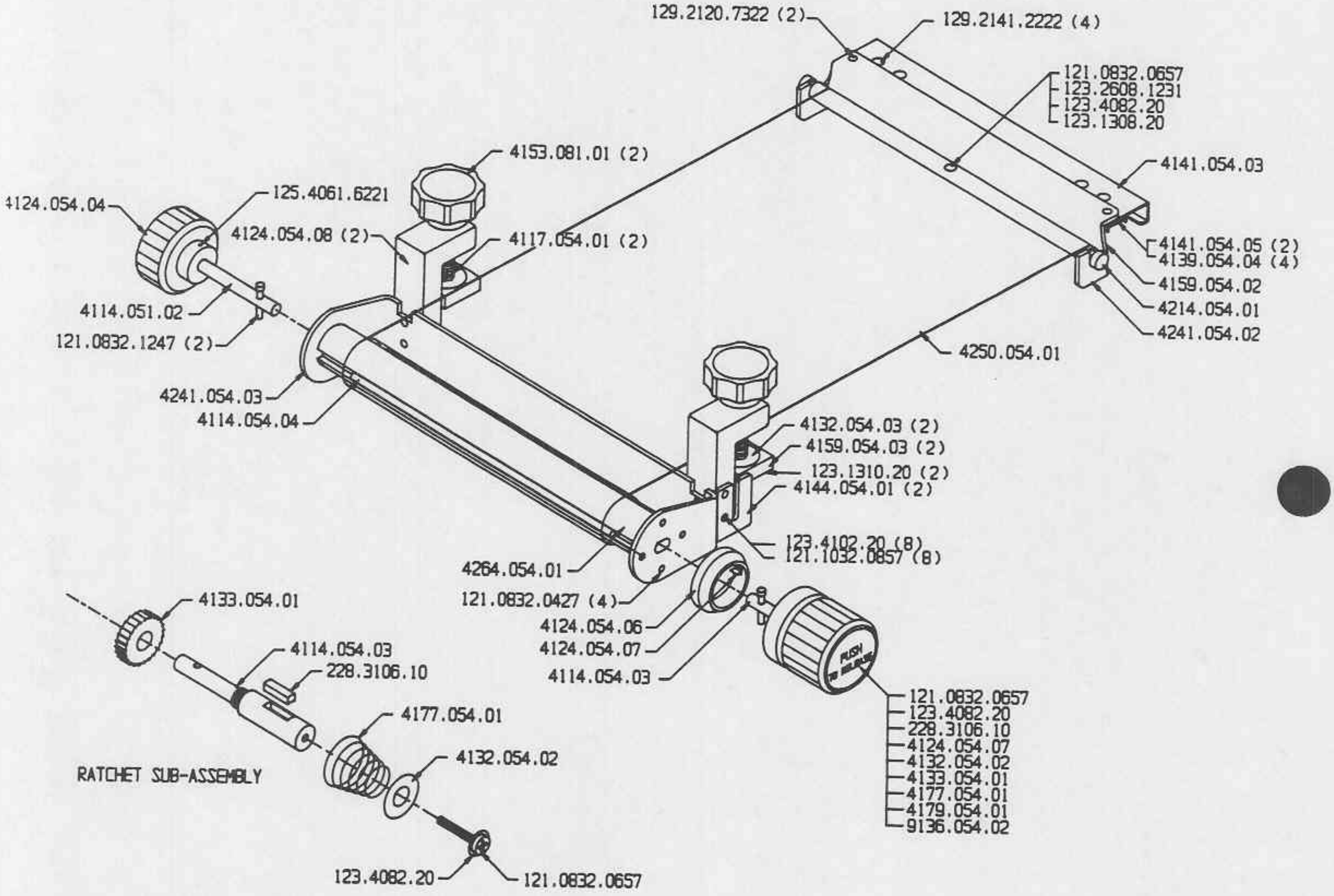
TABLE 4-16 PARTS LIST FOR 5436.504.02 UROLOGICAL RIGHT KNEE CRUTCH


4402.504.01
4114.504.01
121.1420.1067 (2)
4153.504.03
123.1215.20
4141.504.03
4153.504.04
4117.504.01
123.1114.20
123.4102.20
121.1032.0857
124.1032.0621
124.6820.1642
125.4061.0221
9442.504.02
4114.504.02
4129.504.02
129.2251.2620 (3)
4150.054.01 (3)
123.1414.20 (3)
125.4081.6281
4129.504.03
121.1032.0827 (2)
9245.504.02

UROLOGICAL LEFT-HAND KNEE CRUTCH ASM
FIGURE 4-20 LAYOUT FOR 5436.504.03

	Part Number	Description	Quantity	
1.	121.1032.0827	10-32 X 1/2 Flat Steel Philps Screw	2	EA
2.	121.1032.0857	10-32 X 1/2 Pan Steel Philips Screw	1	EA
3.	121.1420.1067	1/4-20 X 5/8 Truss Steel Phlp Screw	2	EA
4.	123.1114.20	9/32ID 5/8OD 1/16Thk Stl SAE Washer	1	EA
5.	123.1215.20	3/8ID 7/8OD 5/64T Stl Wrght Washer	1	EA
6.	123.1414.20	17/64I 1/2Od 1/16T Stl Elect.Washer	3	EA
7.	123.4102.20	#10 Medium Pattern Split Lockwasher	1	EA
8.	124.1032.0621	10-32 X 3/8 Sckt Hd Set Scrw Cup Pt	1	EA
9.	124.6820.1642	1/2-20 X 1 Socket Head Cap Screw	1	EA
10.	125.4061.0221	3/32 Od x 5/8 Long .022 Thk Rollpin	1	EA
11.	125.4081.6281	1/8 Od X 1 Long .028 Thick Rollpin	1	EA
12.	129.2251.2620	1/4 D X .38 Lth X .44Hd Rivet	3	EA
13.	4114.504.01	Knee Crutch Leg Support Shaft	1	EA
14.	4114.504.02	Knee Crutch Clamp Support Shaft	1	EA
15.	4117.504.01	Knee Crutch Table Top Clamp Screw	1	EA
16.	4129.504.02	Knee Crutch Compression Bar	1	EA
17.	4129.504.03	Knee Crutch Locking Strip	1	EA
18.	4141.504.03	Knee Crutch Leg Support Swivel Yoke	1	EA
19.	4150.054.01	Nylon Roller	3	EA
20.	4153.504.03	Reid DK-3 3/8-16 Black Fluted Knob	1	EA
21.	4153.504.04	Reid DK-23 3/8 D Black Fluted Knob	1	EA
22.	4153.504.05	Leg Support Shaft Protective Cap	1	EA
23.	4402.504.01	Knee Crutch Leg Support	1	EA
24.	9245.504.02	Power Top LH Knee Crutch Support	1	EA
25.	9442.504.02	LH Knee Crutch Support Clamp	1	EA

TABLE 4-17 PARTS LIST FOR 5436.504.03 UROLOGICAL LEFT KNEE CRUTCH


129.2120.7322 (2)
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4117.054.01 (2)
4141.054.05 (2)
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4159.054.02
4214.054.01
4241.054.02
4114.051.02
121.0832.1247 (2)
4250.054.01
4241.054.03
4114.054.04
4132.054.03 (2)
4159.054.03 (2)
123.1310.20 (2)
4144.054.01 (2)
123.4102.20 (8)
121.1032.0857 (8)
4264.054.01
121.0832.0427 (4)
4133.054.01
4124.054.06
4124.054.07
4114.054.03
4114.054.03
228.3106.10
PUSH TO RELEASE
121.0832.0657
123.4082.20
228.3106.10
4124.054.07
4132.054.02
4133.054.01
4177.054.01
4179.054.01
9136.054.02
4177.054.01
4132.054.02
RATCHET SUB-ASSEMBLY
123.4082.20
121.0832.0657

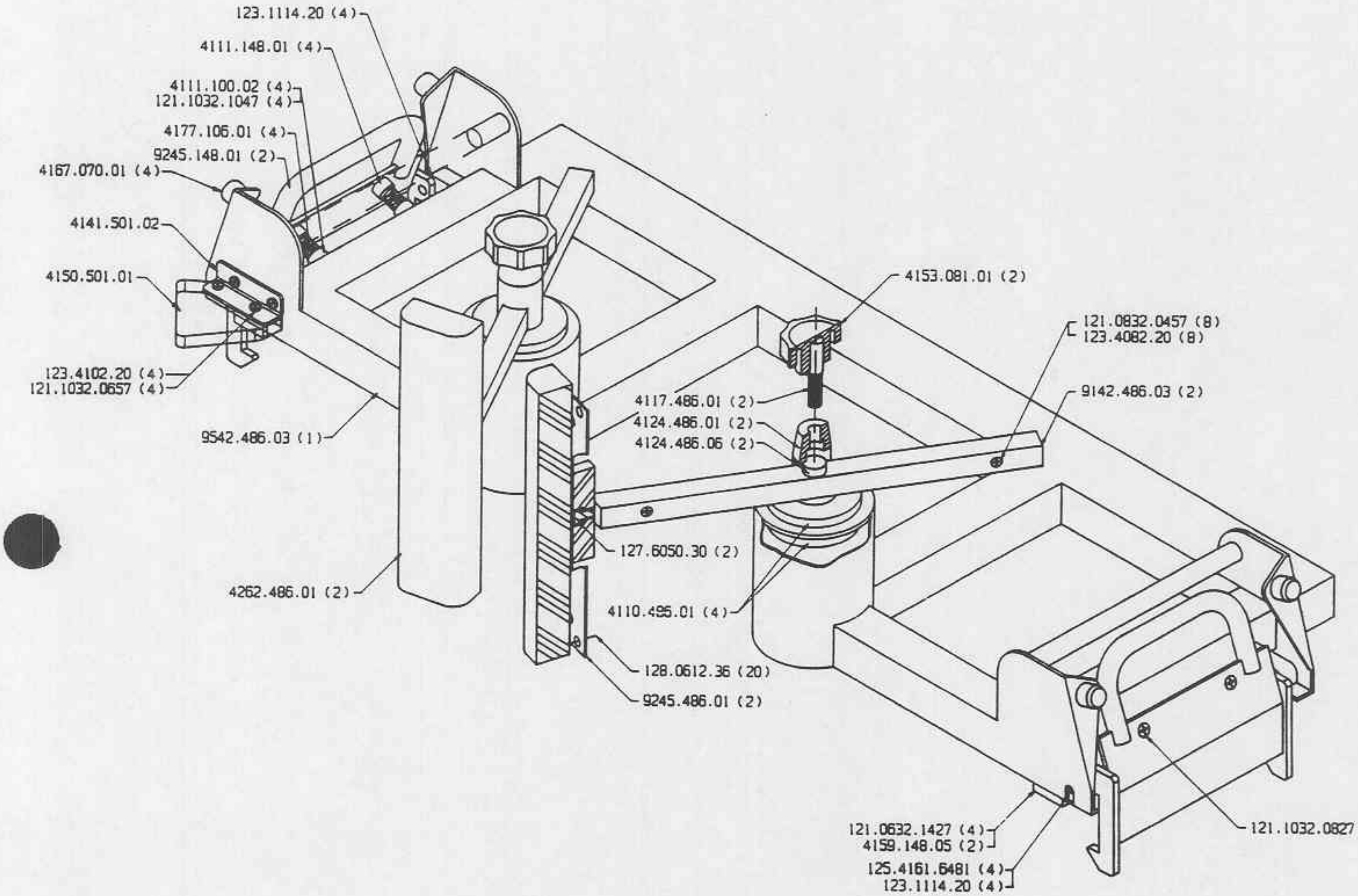
COMPRESSION BAND DEVICE ASSEMBLY
FIGURE 4-21 LAYOUT FOR 5536.500.01

	Part Number	Description	Quantity
1.	121.0832.0427	8-32 X 1/4 Flat Steel Phillips Screw	4 EA
2.	121.0832.0657	8-32 X 3/8 Pan Steel Phillips Screw	2 EA
3.	121.0832.1247	8-32 X 3/4 Filstr Steel Phlps Screw	2 EA
4.	121.1032.0857	10-32 X 1/2 Pan Steel Philips Screw	8 EA
5.	123.1306.20	.150ID .375OD .032T Mach Scrw Washr	4 EA
6.	123.1308.20	.170Id .375Od .032T Mach Scrw Washr	1 EA
7.	123.1310.20	.204ID .438OD .032T Mach Scrw Washr	2 EA
8.	123.2608.1231	#8X3/8 OD White Flat Nylon Washer	1 EA
9.	123.4082.20	#8 Medium Pattern Split Lockwasher	2 EA
10.	123.4102.20	#10 Medium Pattern Split Lockwasher	8 EA
11.	124.1032.0621	10-32 X 3/8 Sckt Hd Set Scrw Cup Pt	2 EA
12.	125.4061.6221	3/32 Od X 1 Long .022 Thick Rollpin	1 EA
13.	129.2120.7322	1/8 X 7/32 X 1/4 Rivet	2 EA
14.	129.2141.2222	9/64 X 3/8 X 5/16 Steel Rivet	4 EA
15.	228.3106.10	3/16 X 5/8 Woodruff Key	1 EA
16.	4114.054.02	Compression Band Straight Shaft	1 EA
17.	4114.054.03	Compression Band Keyed Shaft	1 EA
18.	4114.054.04	Plastic Band Front Shaft	1 EA
19.	4117.054.01	Compression Band Lock Screw	2 EA
20.	4124.054.04	Compression Band Straight Knob	1 EA
21.	4124.054.06	Compression Band Ratch Ring	1 EA
22.	4124.054.07	Compression Band Ratchet Dog	1 EA
23.	4124.054.08	Power Top Front Clamp	2 EA
24.	4132.054.02	11/64 X 7/8 OD Steel Washer	1 EA
25.	4132.054.03	.26ID X 1 OD X .030T Stnls Stl Wshr	2 EA
26.	4133.054.01	Compression Band Ratchet	1 EA

TABLE 4-18 PARTS LIST FOR 5536.500.01 COMPRESSION BAND DEVICE

	Part Number	Description	Quantity	
27.	4139.054.04	Table Rear Clamp Compression Magnet	4	EA
28.	4141.054.03	Rear Clamp Angle	1	EA
29.	4141.054.05	Compression Magnet Bracket	2	EA
30.	4144.054.01	Power Top Front Clamp Keeper	2	EA
31.	4153.504.06	218 Dimco 1/4B-SS Blk Knurled Knob	2	EA
32.	4159.054.02	Compression Clamp Rub Strip	1	EA
33.	4159.054.03	Compression Clamp Lock Pad	2	EA
34.	4177.054.01	Compression Band Release Spring	1	EA
35.	4179.054.01	Compression Band Release Nameplate	1	EA
36.	4214.054.01	Compression Band Rod	1	EA
37.	4241.054.02	Power Top Rear Clamp	1	EA
38.	4241.054.03	Compression Band Support Bracket	1	EA
39.	4250.054.01	Plastic Compression Band	1	EA
40.	4264.054.01	Compression Band Wood Roller	1	EA
41.	9136.054.02	Compresn Band Knurled Knob Assembly	1	EA

TABLE 4-18 P/L FOR 5536.500.01 COMPRESSION BAND DEVICE (continued)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4111.148.01 (4)
4111.100.02 (4)
121.1032.1047 (4)
4177.106.01 (4)
9245.148.01 (2)
4167.070.01 (4)
4141.501.02
4150.501.01
123.4102.20 (4)
121.1032.0657 (4)
9542.486.03 (1)
4262.486.01 (2)
4153.081.01 (2)
121.0832.0457 (8)
123.4082.20 (8)
9142.486.03 (2)
4117.486.01 (2)
4124.486.01 (2)
4124.486.06 (2)
127.6050.30 (2)
4110.495.01 (4)
128.0612.36 (20)
9245.486.01 (2)
121.0632.1427 (4)
4159.148.05 (2)
125.4161.6481 (4)
123.1114.20 (4)
121.1032.0827

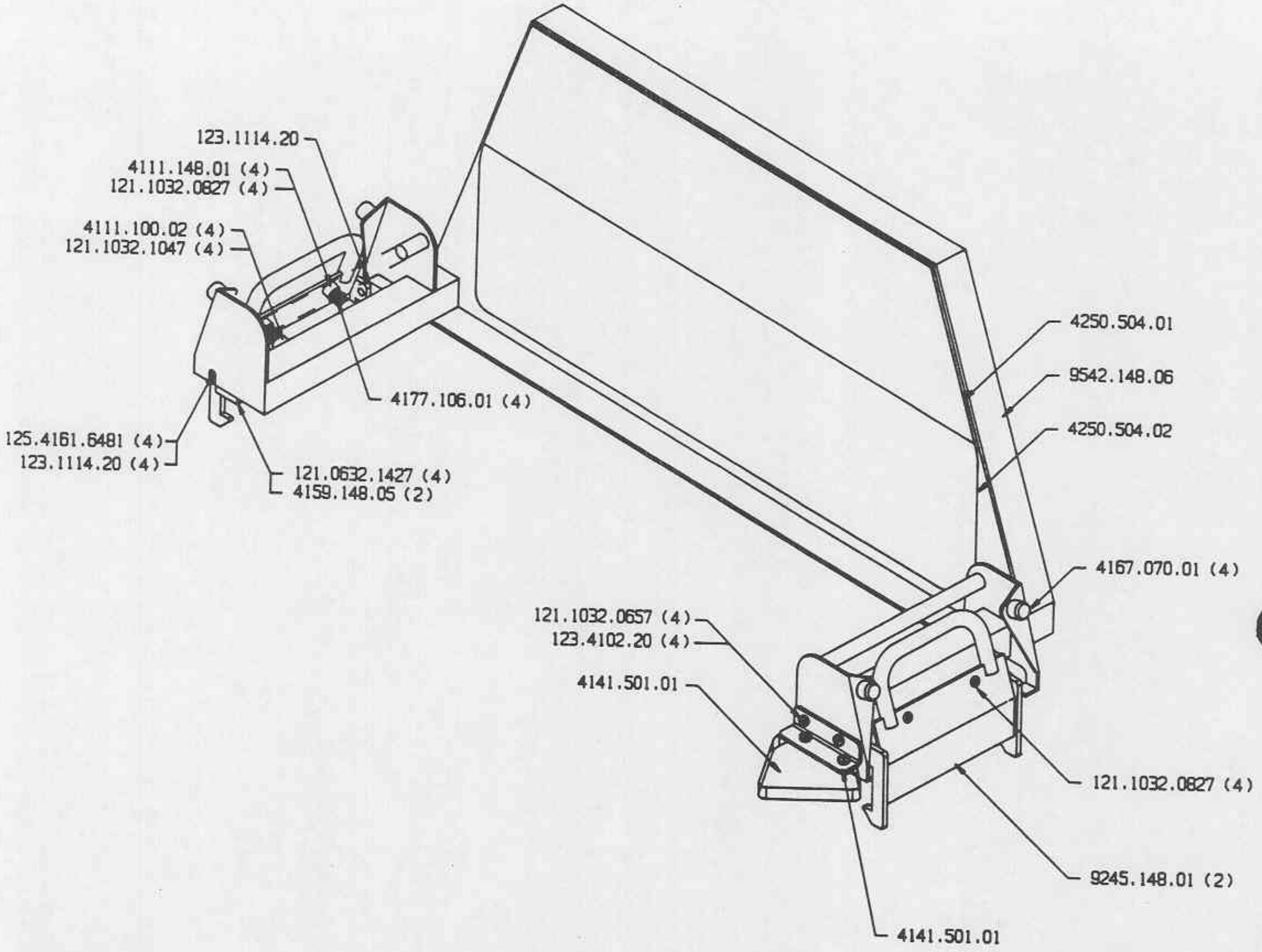
ADJUSTABLE SHOULDER REST ASSEMBLY
FIGURE 4-22 LAYOUT FOR 5536.504.01

	Part Number	Description	Quantity	
1.	121.0832.0457	8-32 X 1/4 Pan Steel Phillips Screw	8	EA
2.	121.1032.0657	10-32 X 3/8 Pan Steel Philips Screw	4	EA
3.	121.1032.0827	10-32 X 1/2 Flat Steel Philps Screw	4	EA
4.	121.1032.0847	10-32 X 1/2 Filstr Steel Phlp Screw	4	EA
5.	123.1114.20	9/32ID 5/8OD 1/16Thk Stl SAE Washer	4	EA
6.	123.4082.20	#8 Medium Pattern Split Lockwasher	8	EA
7.	123.4102.20	#10 Medium Pattern Split Lockwasher	4	EA
8.	124.1032.0621	10-32 X 3/8 Sckt Hd Set Scrw Cup Pt	2	EA
9.	125.4161.6481	1/4 Od X 1 Long .048 Thick Rollpin	4	EA
10.	126.1061.2270	6A X 3/4 Flat Head Steel Screw	4	EA
11.	127.6050.30	5/16 X 3/8 Stripper Bolt	2	EA
12.	128.0612.36	#6 X 3/4 Phlps Oval Wood Screw	20	EA
13.	4110.486.01	Thrust Disc for Shoulder Rest	4	EA
14.	4111.100.02	Bushing For Shutter	4	EA
15.	4111.148.01	Spring Bushing	4	EA
16.	4117.486.01	Lock Screw for Shoulder Rest	2	EA
17.	4124.486.01	Shoulder Rest Arm Guide	2	EA
18.	4124.486.06	Locking Plug for Shoulder Rest	2	EA
19.	4141.501.02	LH Radiation Shield Deflector Angle	1	EA
20.	4150.501.01	Radiation Shield Deflector Cam	1	EA
21.	4153.504.06	218 Dimco 1/4B-SS Blk Knurled Knob	2	EA
22.	4159.148.05	1/2 Inch Rub Strip	2	EA
23.	4167.070.01	8-32 X 3/8 Stud Rubber Bumper	4	EA
24.	4177.106.01	Bumper Spring	4	EA
25.	4262.486.01	8-1/2 Inch Straight Shoulder Pad	2	EA
26.	9142.486.03	Shoulder Pad Arm	2	EA

TABLE 4-19 PARTS LIST FOR 5536.504.01 ADJUSTABLE SHOULDER REST

	Part Number	Description	Quantity
27.	9245.148.01	Rail Hook Assembly	2 EA
28.	9245.486.01	Straight Shoulder Pad Plate	2 EA
29.	9542.486.03	Notched Top Shoulder Rest	1 EA

TABLE 4-19 P/L FOR 5536.504.01 ADJUSTABLE SHOULDER REST (continued)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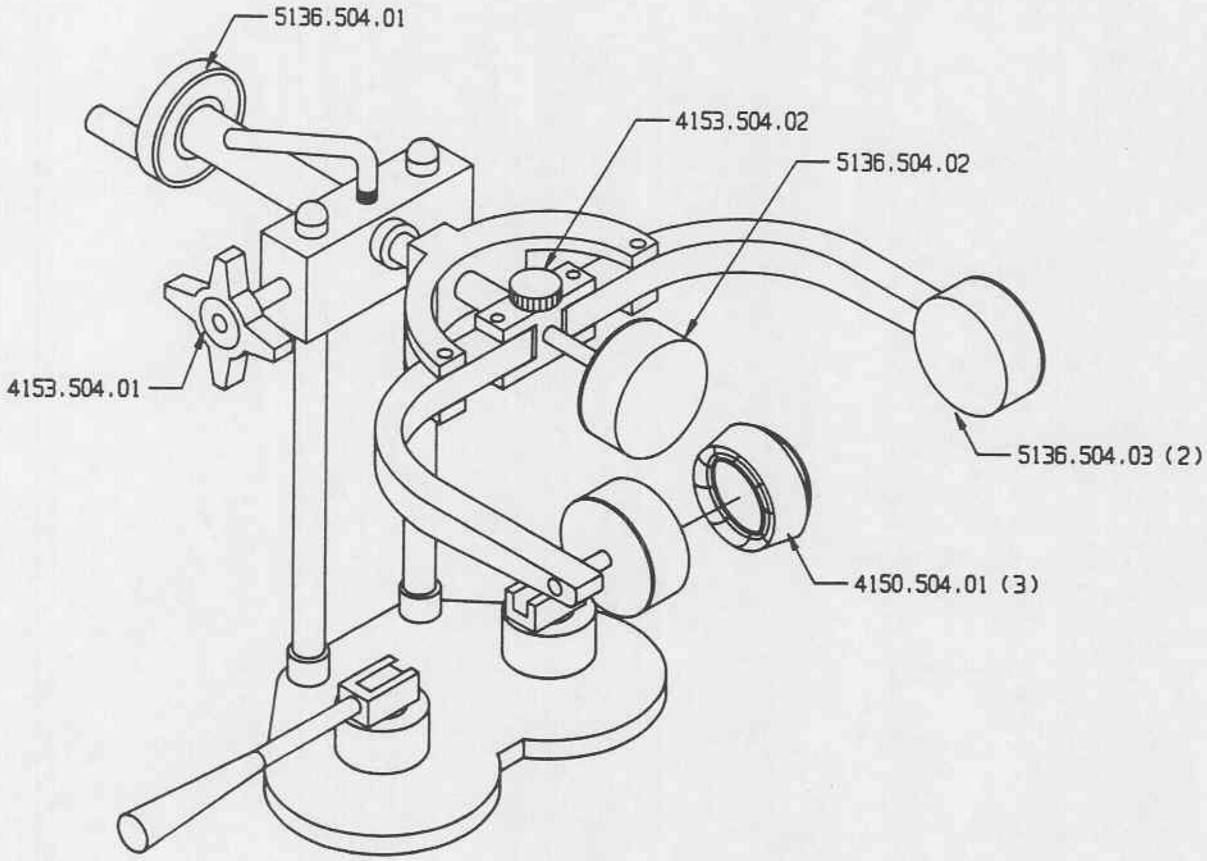
121.1032.0827 (4)
4111.100.02 (4)
121.1032.1047 (4)
4177.106.01 (4)
125.4161.6481 (4)
123.1114.20 (4)
121.0632.1427 (4)
4159.148.05 (2)
4250.504.01
9542.148.06
4250.504.02
4167.070.01 (4)
121.1032.0657 (4)
123.4102.20 (4)
4141.501.01
121.1032.0827 (4)
9245.148.01 (2)
4141.501.01

FOOTREST ASSEMBLY
FIGURE 4-23 LAYOUT FOR 5536.504.02

	Part Number	Description	Quantity
1.	121.1032.0657	10-32 X 3/8 Pan Steel Philips Screw	4 EA
2.	121.1032.0827	10-32 X 1/2 Flat Steel Philps Screw	4 EA
3.	121.1032.0847	10-32 X 1/2 Filstr Steel Phlp Screw	4 EA
4.	123.1114.20	9/32ID 5/8OD 1/16Thk Stl SAE Washer	4 EA
5.	123.4102.20	#10 Medium Pattern Split Lockwasher	4 EA
6.	125.4161.6481	1/4 Od X 1 Long .048 Thick Rollpin	4 EA
7.	126.1061.2270	6A X 3/4 Flat Head Steel Screw	4 EA
8.	4111.100.02	Bushing For Shutter	4 EA
9.	4111.148.01	Spring Bushing	4 EA
10.	4141.501.01	RH Radiation Shield Deflector Angle	1 EA
11.	4150.501.01	Radiation Shield Deflector Cam	1 EA
12.	4159.148.05	1/2 Inch Rub Strip	2 EA
13.	4167.070.01	8-32 X 3/8 Stud Rubber Bumper	4 EA
14.	4177.106.01	Bumper Spring	4 EA
15.	4250.504.01	Foot Rest Front Half Tread	1 EA
16.	4250.504.02	Foot Rest Rear Half Tread	1 EA
17.	9245.148.01	Rail Hook Assembly	2 EA
18.	9542.148.06	Notched Top Foot Rest	1 EA

TABLE 4-20 PARTS LIST FOR 5536.504.02 FOOTREST

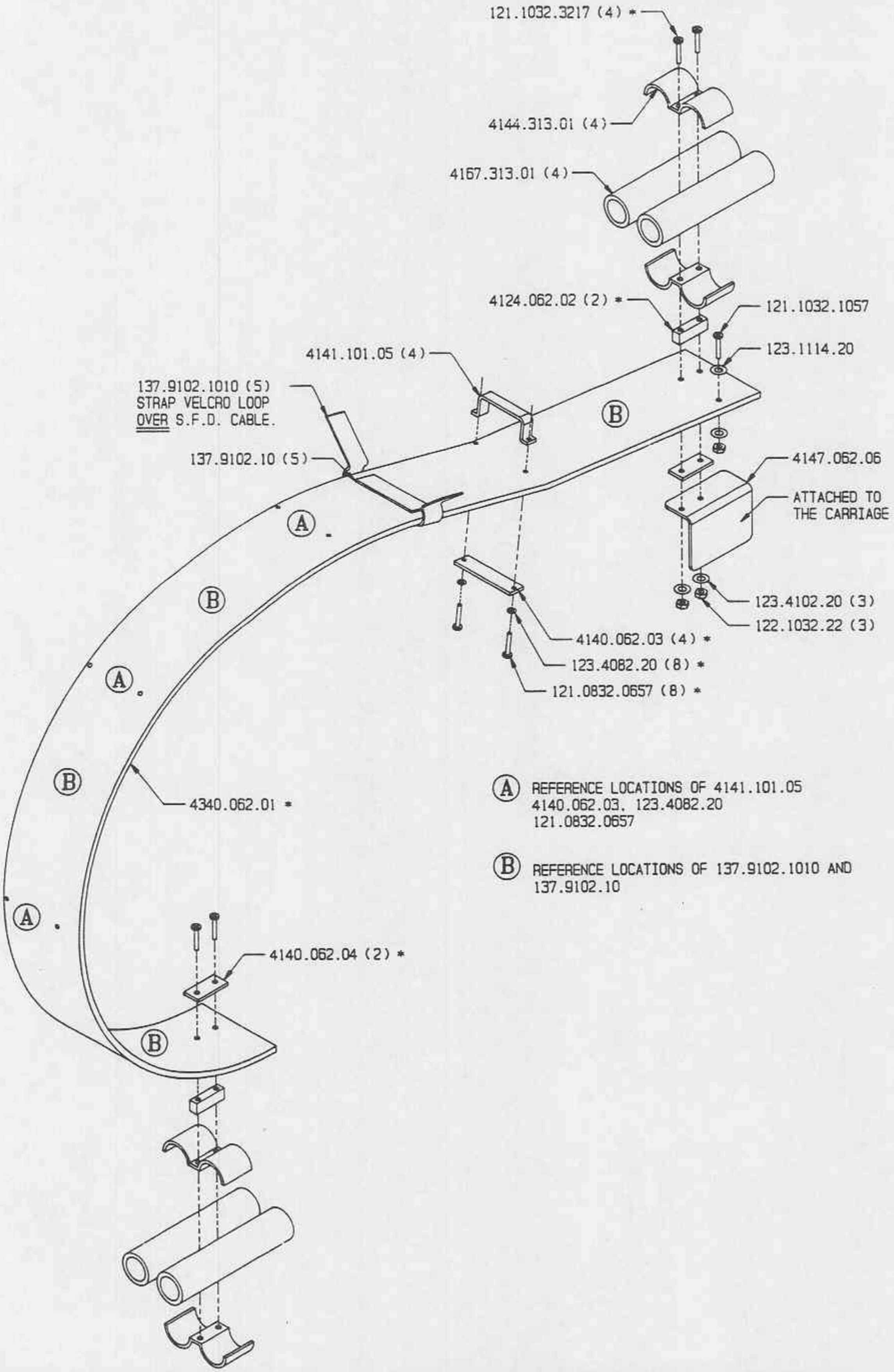

5136.504.01
4153.504.02
5136.504.02
4153.504.01
5136.504.03 (2)
4150.504.01 (3)

VACUUM HEAD CLAMP
FIGURE 4-24 LAYOUT FOR 9491.201

PART NUMBER 9491.201

4001	SIDE PAD ADJUSTMENT KNOB	1 EA
4003	HEADCLAMP HEIGHT ADJUSTMENT KNOB	1 EA
4008	HEADCLAMP TOP PAD	1 EA
4009	HEADCLAMP TOP PAD ADJUSTMENT KNOB	1 EA
4010	HEADCLAMP SIDE PAD	2 EA
4021	SPONGE PAD COVER	3 EA

TABLE 4-21 PARTS LIST FOR THE VACUUM HEAD CLAMP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4144.313.01 (4)
4167.313.01 (4)
4124.062.02 (2) *
121.1032.1057
123.1114.20
4141.101.05 (4)
137.9102.1010 (5)
STRAP VELCRO LOOP
OVER S.F.D. CABLE.
137.9102.10 (5)
4147.062.06
ATTACHED TO
THE CARRIAGE
123.4102.20 (3)
122.1032.22 (3)
4140.062.03 (4) *
123.4082.20 (8) *
121.0832.0657 (8) *
4340.062.01 *
4140.062.04 (2) *
Ⓐ
Ⓑ

Ⓐ REFERENCE LOCATIONS OF 4141.101.05
4140.062.03, 123.4082.20
121.0832.0657

Ⓑ REFERENCE LOCATIONS OF 137.9102.1010 AND
137.9102.10

FIGURE 4-25 TABLE HIGH VOLTAGE CABLE SUPPORT BAND ASSEMBLY

PART NUMBER	DESCRIPTION	QTY
121.1032.3217	10-32X2 ROUND STEEL PHILLIPS SCREW	4
4144.313.01	HIGH VOLTAGE CABLES TWO-LEGGED CLAMP	4
4167.313.01	1.375ID X 6" X.065W KNIFE CUT TUBE	4
4124.062.02	MXT 90/15 TABLE CABLE ROUTING SPACER	2
121.1032.1057	10-32X5/8 PAN STEEL PHILLIPS SCREW	1
123.1114.20	9/32ID 5/8OD 1/16THK STEEL SAE WASHER	1
4147.062.06	MIL TABLE CABLE SUPPORT BAND BRACKET	1
123.4102.20	#10 MEDIUM PATTERN SPLIT LOCKWASHER	3
122.1032.22	10-32 DOUBLE CHAMFERED HEX NUT STEEL	3
4141.101.05	CTC HIGH VOLTAGE CLAMP BRACKET	4
4140.062.03	MXT 90/15 CABLE BAND SUPPORT BRACKET	4
123.4082.20	#8 MEDIUM PATTERN SPLIT LOCKWASHER	8
121.0832.0657	8-32 X 3/8 PAN STEEL PHILLIPS SCREW	8
137.9102.1010	1" NATURAL COLOR VELCRO LOOP	5
137.9102.10	1" BLACK COLOR VELCRO HOOK, ADHESIVE	5
4340.062.01	MIL TABLE CABLE SUPPORT BAND	1
4140.062.04	MXT 90/15 CABLE BAND END SUPPORT BRCKT	2

TABLE 4-22 PARTS LIST FOR TABLE HIGH VOLTAGE CABLE SUPPORT BAND ASSEMBLY

CHAPTER 8

TUBESTAND

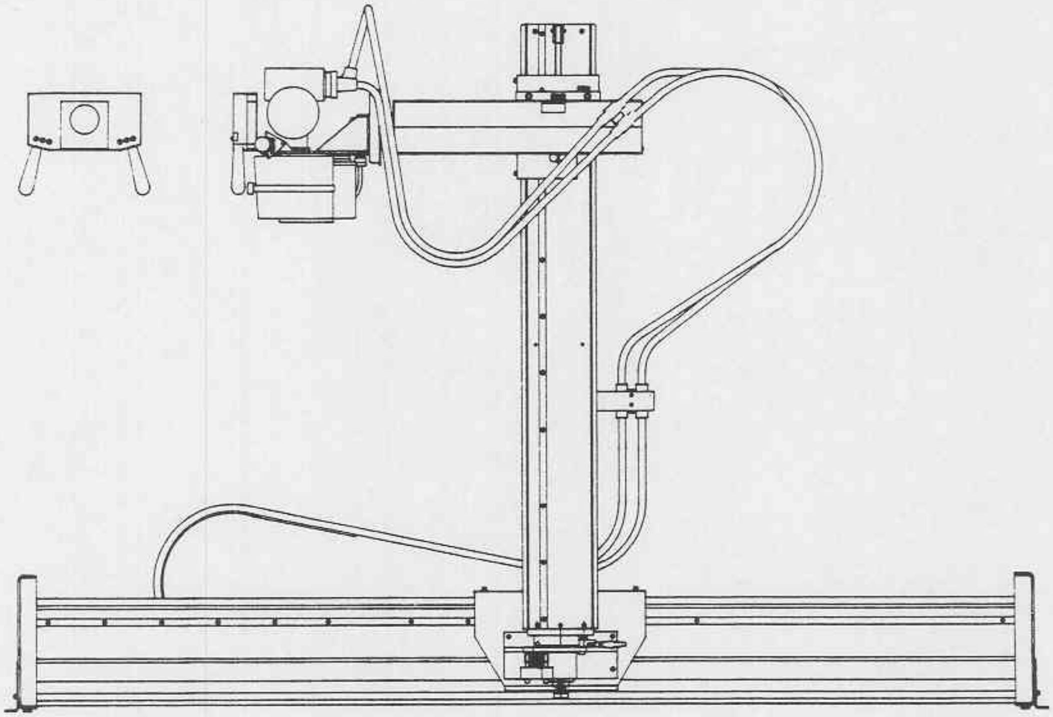


TABLE OF CONTENTS
CHAPTER 8 - CTC TUBESTAND

SECTION NUMBER	DESCRIPTION	PAGE NUMBER
SECTION 1 - GENERAL		1-1
1.1	SCOPE	1-1
1.2	DESCRIPTION	1-1
1.3	TUBESTAND, SPECIFICATIONS	1-4
SECTION 2 - CIRCUIT DESCRIPTION		2-1
2.1	CIRCUIT DESCRIPTION	2-1
2.2	TUBESTAND CIRCUIT OPERATION	2-1
2.3	LOCK CONTROL CIRCUIT	2-1
2.4	FAN CIRCUIT	2-1
2.5	SID SWITCHES	2-2
2.6	COLLIMATOR CIRCUIT DESCRIPTION	2-4
SECTION 3 - MAINTENANCE		3-1
3.1	PREVENTIVE MAINTENANCE	3-1
3.1.1	ELECTRICAL LOCK FAILURE	3-2
3.1.2	STEEL CABLE REPLACEMENT	3-2
3.2	COLLIMATOR	3-2
SECTION 4 - PARTS LISTS		4-1

LIST OF FIGURES
CHAPTER 8 - CTC TUBESTAND

FIGURE NUMBER		DESCRIPTION	PAGE NUMBER
1-1	TUBESTAND ASSEMBLY		1-2
2-1	TUBESTAND SCHEMATIC		2-3
4-1	CTC MAIN WIRING DIAGRAM		4-2
4-2	5536.101.01	CTC MAIN FRAME ASM	4-3
4-3	5536.101.02	CTC VERTICAL & LATERAL CARRIAGE ASM	4-5
4-4	5536.101.05	HORIZONTAL CARRIAGE ASM	4-8
4-5	5536.101.06	CTC VERTICAL COLUMN ASM	4-10
4-6	6810.100	FLOOR-MOUNTED TUBESTAND ASM	4-13

LIST OF TABLES

TABLE NUMBER	DESCRIPTION	PAGE NUMBER
4-1	PARTS LIST FOR 5536.101.01 CTC MAIN FRAME ASM	4-4
4-2	PARTS LIST FOR 5536.101.02 CTC VERTICAL & LATERAL CARRIAGE ASM	4-6
4-3	PARTS LIST FOR 5536.101.05 CTC HORIZONTAL CARRIAGE ASM	4-9
4-4	PARTS LIST FOR 5536.101.06 CTC VERTICAL COLUMN ASM	4-11
4-5	PARTS LIST FOR 6810.100 MILITARY FLOOR-MOUNTED TUBESTAND ASM	4-14

CHAPTER 8 - CTC TUBESTAND

SECTION 1 - GENERAL

1.1 SCOPE

This chapter describes the maintenance of the Continental X-ray Corporation tubestand, collimator and over-table x-ray tube. Other components are required to complete the x-ray system. Since these components are the subjects of their own chapters, they will not be discussed except as applies to the tubestand.

1.2 DESCRIPTION:

The floor mounted CTC tubestand assembly has been designed to be used in conjunction with the MXT-90/15 radiographic/fluoroscopic table and the mobile wall cassette holder. The tubestand assembly consists of the 82" column with rail base, vertical and transverse carriages, tilting tube mount with attached control panel, and 10′ free standing floor rail. An over-table collimator and x-ray tube, is mounted to the tilting tube mount (FIGURE 1-1).

The tubestand is equipped with a rotating vertical column for lateral radiography and parking clear of the table. The rotation of the column around its vertical axis is ± 90° and is indexed every 90°.

The vertical carriage travels on the outside of the vertical column. The 60" vertical travel of the carriage positions the focal spot between 17" and 77" from the floor, providing a 40" source to image distance (SID) above a 36" horizontal table top. The vertical travel is controlled by a positive electric lock activated by a switch on the control panel.

The transverse carriage mounts to the side of the vertical carriage and provides for 16" of lateral travel. The lateral travel is controlled by a positive electric lock activated by a switch on the control panel. The transverse carriage also features a push button automatic centering of the focal spot over the centerline of the table and/or the grid chamber.

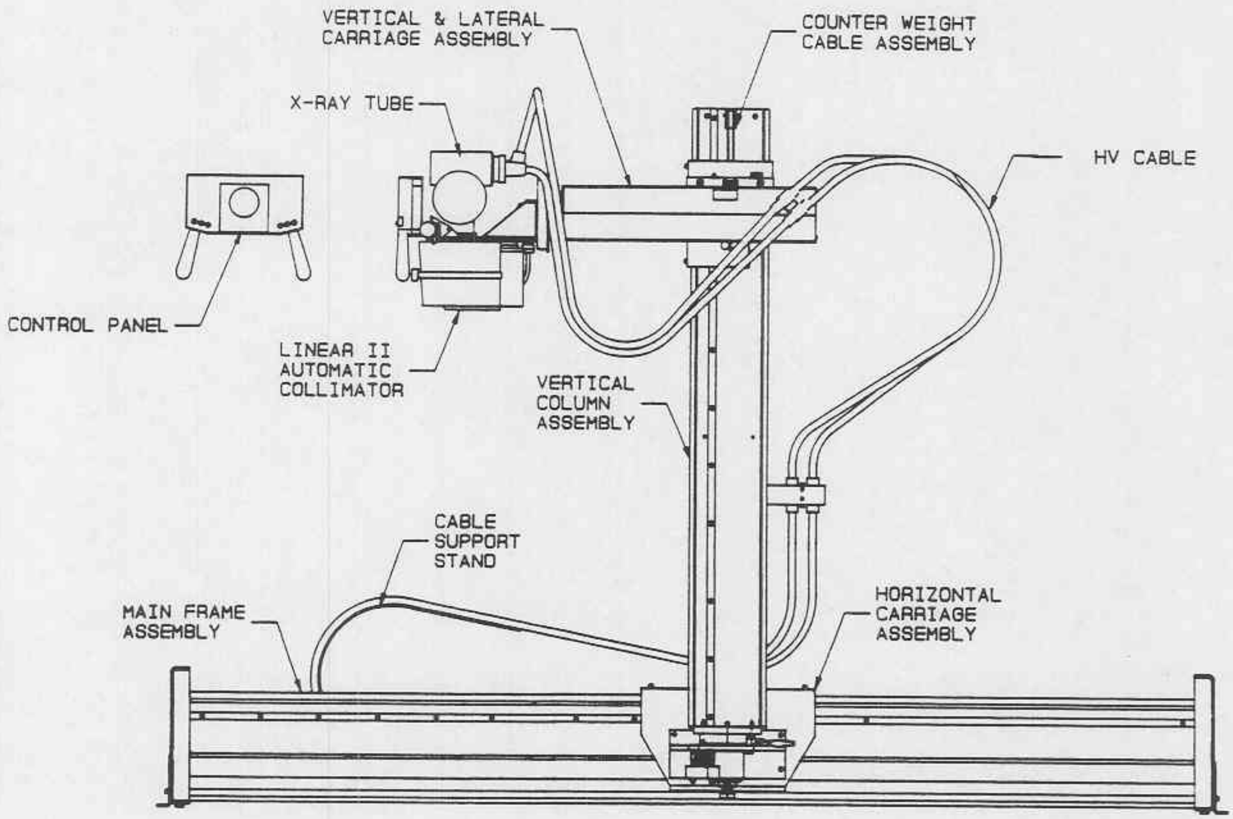

VERTICAL & LATERAL CARRIAGE ASSEMBLY
COUNTER WEIGHT CABLE ASSEMBLY
X-RAY TUBE
HV CABLE
CONTROL PANEL
LINEAR II AUTOMATIC COLLIMATOR
VERTICAL COLUMN ASSEMBLY
CABLE SUPPORT STAND
MAIN FRAME ASSEMBLY
HORIZONTAL CARRIAGE ASSEMBLY

FIGURE 1-1 TUBESTAND ASSEMBLY

1.2 DESCRIPTION (continued)

The tilting tube mount is secured to the transverse carriage. A tapered bearing assembly allows for smooth rotation of the tube mount and x-ray tube about the lateral axis. The design provides for a rotation of plus or minus (±) 180° of the tube mount and x-ray tube. An electric lock ring magnet clamps this rotation at any desired position and is activated by a switch on the control panel.

The tube mount can be tilted forward and backward for exposures when these angles are necessary. Through the use of a mechanical locking mechanism, the tube mount can be tilted forward at a pitch up to 30° and backward at a pitch up to 20°.

The tubestand assembly rides on the 10′ free standing floor rail. A longitudinal travel of 101" is provided for by this configuration. The longitudinal travel is controlled by an electric lock activated by a switch on the control panel.

The collimator, included in this system, is equipped with automatic shutter setting when the SID is 40". There are switches on the tubestand for both vertical and horizontal SID which will indicate to the collimator that the SID is 40". When the SID is other than 40" the collimator shutters can be adjusted manually to the correct dimensions. The collimator is used to focus the X-ray beam and limit stray radiation.

The over-table x-ray tube (Eureka type RAD-13 Diamond) is used to produce radiation for radiographic procedures.

1.3 TUBESTAND, SPECIFICATIONS

1.3.1 TUBESTAND PHYSICAL

DIMENSIONS	Length- 120 1/2" Width- 54" ± 8" Height- 86 172"

WEIGHT

Tubestand (structure)	1035 lbs
Tubestand (assembly)	1100 lbs

TRAVEL DIMENSIONS

Longitudinal	101"
Vertical	60"
Lateral	16"
Column Rotation	± 90°
Tube Rotation	± 180°
Tube Pitch	30° forward 20° backward

1.3.2 ELECTRICAL POWER REQUIREMENTS

115VAC 50 - 60Hz (from auxiliary cabinet).

SECTION 2 - CIRCUIT DESCRIPTION

2.1 CIRCUIT DESCRIPTION

This section describes the operation of the Model CTC tubestand electrical circuitry.

2.2 TUBESTAND CIRCUIT OPERATION

The tubestand schematic diagram is shown in (Figure 2-1). The circuitry consists of four (4) independent electrical circuits: the Lock Control Circuit, the Fan Circuit and two (2) SID switches.

2.3 LOCK CONTROL CIRCUIT

The Lock Control Circuit is powered by 24VDC from the auxiliary cabinet. It is comprised of seven (7) switches for controlling the operation of the transverse, longitudinal, vertical and roll locks. All switches, except for the center switch, on the rail are normally closed push buttons located on the tubestand handle. As a result, pressing the push buttons disengages the locks by de-energizing them. The center switch on the rail is a normally open microswitch.

When the ALL push button switch is pressed, it de-energizes all locks so that the tubestand is free to move in all directions.

Pressing the LAT (Lateral - Transverse) push button releases the lateral lock so that the over-table tube can be moved laterally across the width of the table. However, if LAT CEN (lateral center) is pressed, the lateral lock automatically engages when the tube is centered over the table because the cam-operated (center) microswitch closes. Pressing LAT releases tube carriage from centered position.

The operation of the LONG (longitudinal), VERT (vertical), and ROLL lock circuits is similar. When these switches are pressed, they release their respective locks, freeing the associated tubestand motion.

2.4 FAN CIRCUIT

The x-ray tube mounted on the tubestand generates a significant amount of heat. As a result, a fan, operating from 115VAC, is installed for cooling the tube.

2.5 SID SWITCHES

The horizontal and vertical SID (source-to-image distance) switches are cam-operated microswitches. These switches automatically close when the source-to-image distance is 40" (1016mm). The vertical SID switch "notifies" the collimator that the over-table tube is 40" (1016mm) above the table top. When the table top is tilted at 90°, the horizontal SID switch indicates that the tube is 40" (1016mm) from the wall cassette holder. Both switches receive plus (+) 15VDC from the collimator on the tubestand.

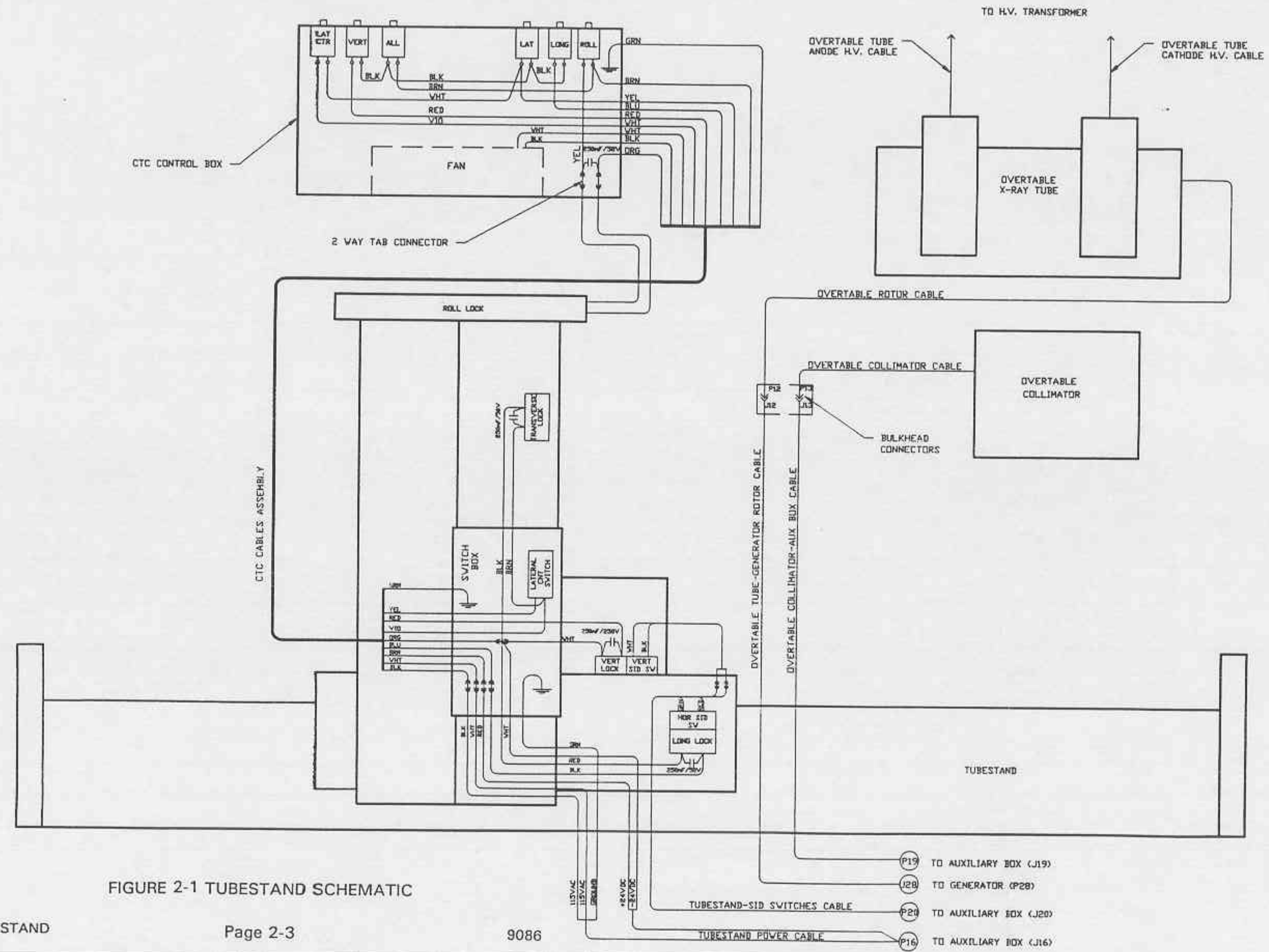

TO H.V. TRANSFORMER
OVERTABLE TUBE ANODE H.V. CABLE
OVERTABLE TUBE CATHODE H.V. CABLE
OVERTABLE X-RAY TUBE
LAT CTR
VERT
ALL
LAT
LONG
ROLL
GRN
BLK
BRN
WHT
RED
VIO
YEL
BLU
ORG
FAN
250mF/50V
CTC CONTROL BOX
2 WAY TAB CONNECTOR
ROLL LOCK
TRANSVERSE LOCK
250mF/50V
CTC CABLES ASSEMBLY
SWITCH BOX
LATERAL CNT SWITCH
250mF/250V
VERT LOCK
VERT STD SW
HOR STD SW
LONG LOCK
250mF/50V
TUBESTAND
OVERTABLE ROTOR CABLE
OVERTABLE COLLIMATOR CABLE
OVERTABLE COLLIMATOR
P12
J12
P13
J13
BULKHEAD CONNECTORS
OVERTABLE TUBE-GENERATOR ROTOR CABLE
OVERTABLE COLLIMATOR-AUX BOX CABLE
115VAC
115VAC
GROUND
+24VDC
-24VDC
TUBESTAND-SID SWITCHES CABLE
TUBESTAND POWER CABLE
P19
TO AUXILIARY BOX (J19)
J28
TO GENERATOR (P28)
P20
TO AUXILIARY BOX (J20)
P16
TO AUXILIARY BOX (J16)

FIGURE 2-1 TUBESTAND SCHEMATIC

SEE ADJACENT FOLDOUT FOR THIS PAGE.

FIGURE 2-1 TUBESTAND SCHEMATIC

2.6 COLLIMATOR CIRCUIT DESCRIPTION

Refer to the over-table collimator manual included as chapter 12 for complete collimator circuit description.

SECTION 3 - MAINTENANCE

3.1 PREVENTIVE MAINTENANCE

The tubestand requires some basic, periodic maintenance. It is suggested that this maintenance be performed every 90 days.

Perform a general inspection throughout the assembly noting any worn or damaged parts. Make any necessary repairs or replacements. Check the hardware of the assembly, (nuts and bolts),to ensure that they are adequately tightened.

The exterior of the tubestand should be wiped down with a mild soapy solution and clean, dry cloths to rid it of dust and foreign materials. Particular attention should be paid to the steel transport rails.

Power to the tubestand should be applied and each function operated at least once. All travel features should be checked to ensure there is smooth travel and to determine that each electric lock is operating properly. The mechanical locks should be checked manually.

3.1 PREVENTIVE MAINTENANCE (continued)

Every 6 months, in addition to the 90 day maintenance, it is suggested that all pulleys be repacked with Lubriplate. All steel cables should be checked for fraying and wear, and replaced, if necessary.

3.1.1 ELECTRICAL LOCK FAILURE

The tubestand is basic in its electrical design. If power is applied and none of the electrically controlled locks function, it may be assumed that the problem is located at the power source. Check to make sure all connections from the power supply are proper. If so, refer to the chapter concerning the appropriate power supply.

If there is a malfunction by only one (1) of the electrically controlled locks, that lock should be checked to ensure that it is positioned properly. The locks are all adjustable to increase or decrease drag. If the lock continues to not function properly after adjustments are made and after the connections are determined to be adequate, the lock itself should be replaced.

3.1.2 STEEL CABLE REPLACEMENT

If it is determined that a steel cable needs replacing, remove the xollimator and x-ray tube first (refer to Chapter 2 - Installation).

Remove the 3 (three) 3/8" bolts that secure the column to the longitudinal carriage and carefully lay the column down.

With the column in this position, pull the counterweight to the top opening in the column and remove the defective cables from the counterweight as well as the vertical carriage. Replace with new cables.

With the replacement cables attached, carefully lift the column back into the upright position and secure it to the longitudinal carriage with the 3/8" bolts.

3.2 COLLIMATOR

The collimator should be checked and adjusted as necessary. The procedure for adjusting the collimator is detailed in the over-table collimator manual, chapter 12.

SECTION 4 - PARTS LISTS

NOTE

This section printed on one side of page, only.

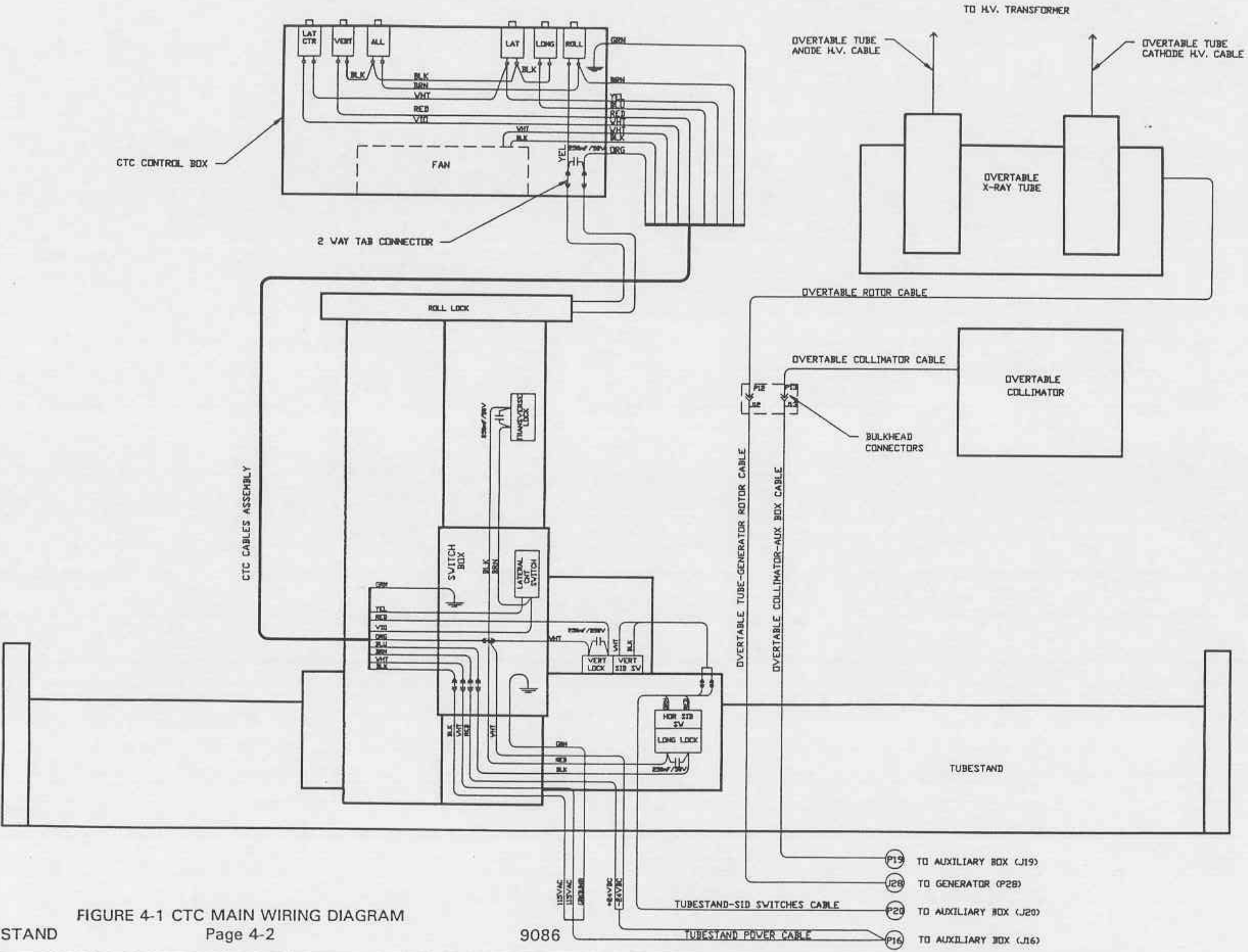
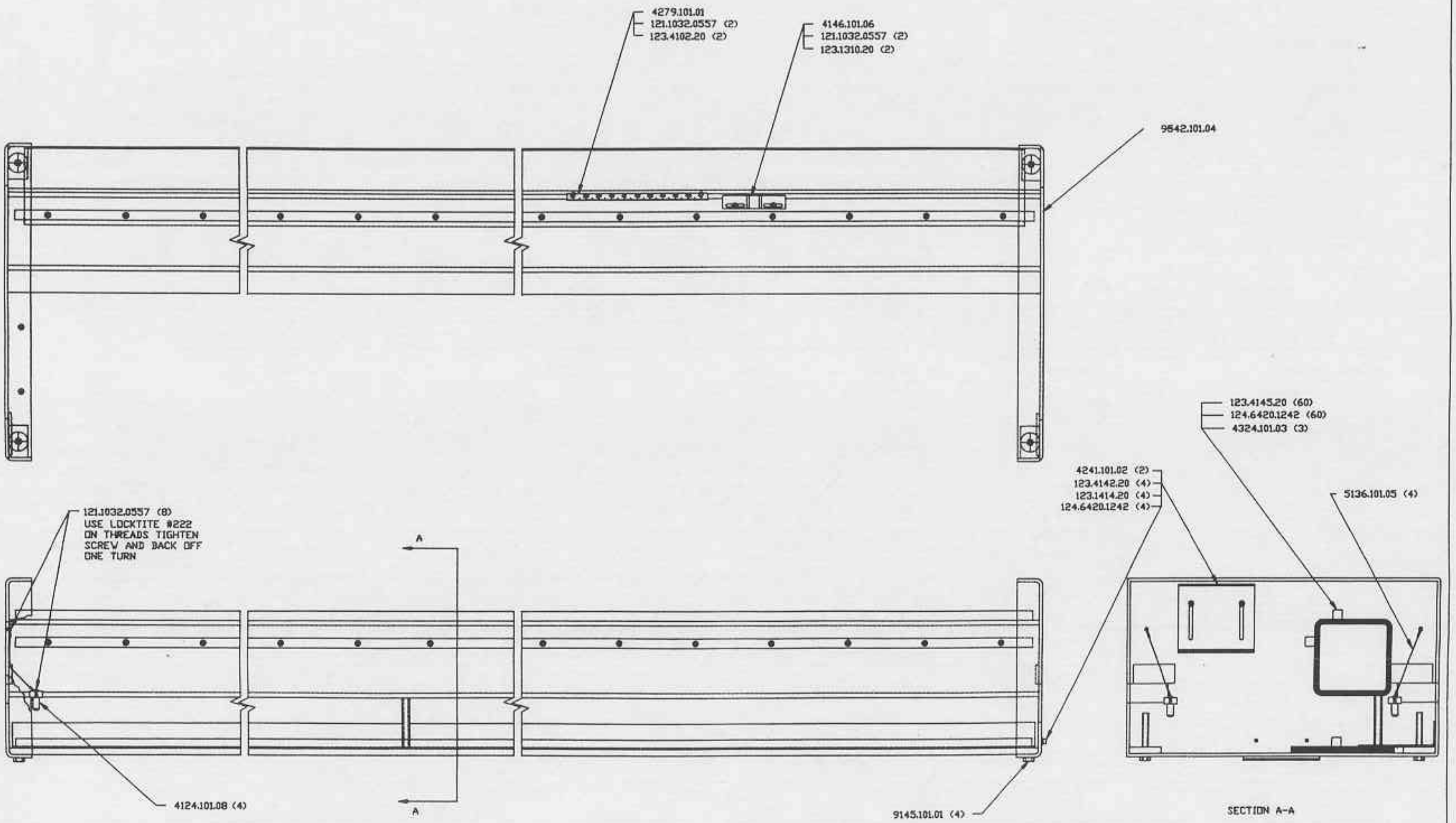

TO H.V. TRANSFORMER
OVERTABLE TUBE ANODE H.V. CABLE
OVERTABLE TUBE CATHODE H.V. CABLE
OVERTABLE X-RAY TUBE
LAT CTR
VERT
ALL
LAT
LONG
ROLL
CTC CONTROL BOX
FAN
2 WAY TAB CONNECTOR
BLK
BRN
WHT
RED
VIO
GRN
YEL
BLU
ORG
ROLL LOCK
OVERTABLE ROTOR CABLE
OVERTABLE COLLIMATOR CABLE
OVERTABLE COLLIMATOR
P12
J12
P13
J13
BULKHEAD CONNECTORS
TRANSVERSE LOCK
CTC CABLES ASSEMBLY
SWITCH BOX
LATERAL CNT SWITCH
OVERTABLE TUBE-GENERATOR ROTOR CABLE
OVERTABLE COLLIMATOR-AUX BOX CABLE
VERT LOCK
VERT SID SW
HOR SID SW
LONG LOCK
TUBESTAND
115VAC
115VAC
GROUND
+24VDC
-24VDC
TUBESTAND-SID SWITCHES CABLE
TUBESTAND POWER CABLE
P19
TO AUXILIARY BOX (J19)
J28
TO GENERATOR (P28)
P20
TO AUXILIARY BOX (J20)
P16
TO AUXILIARY BOX (J16)

FIGURE 4-1 CTC MAIN WIRING DIAGRAM

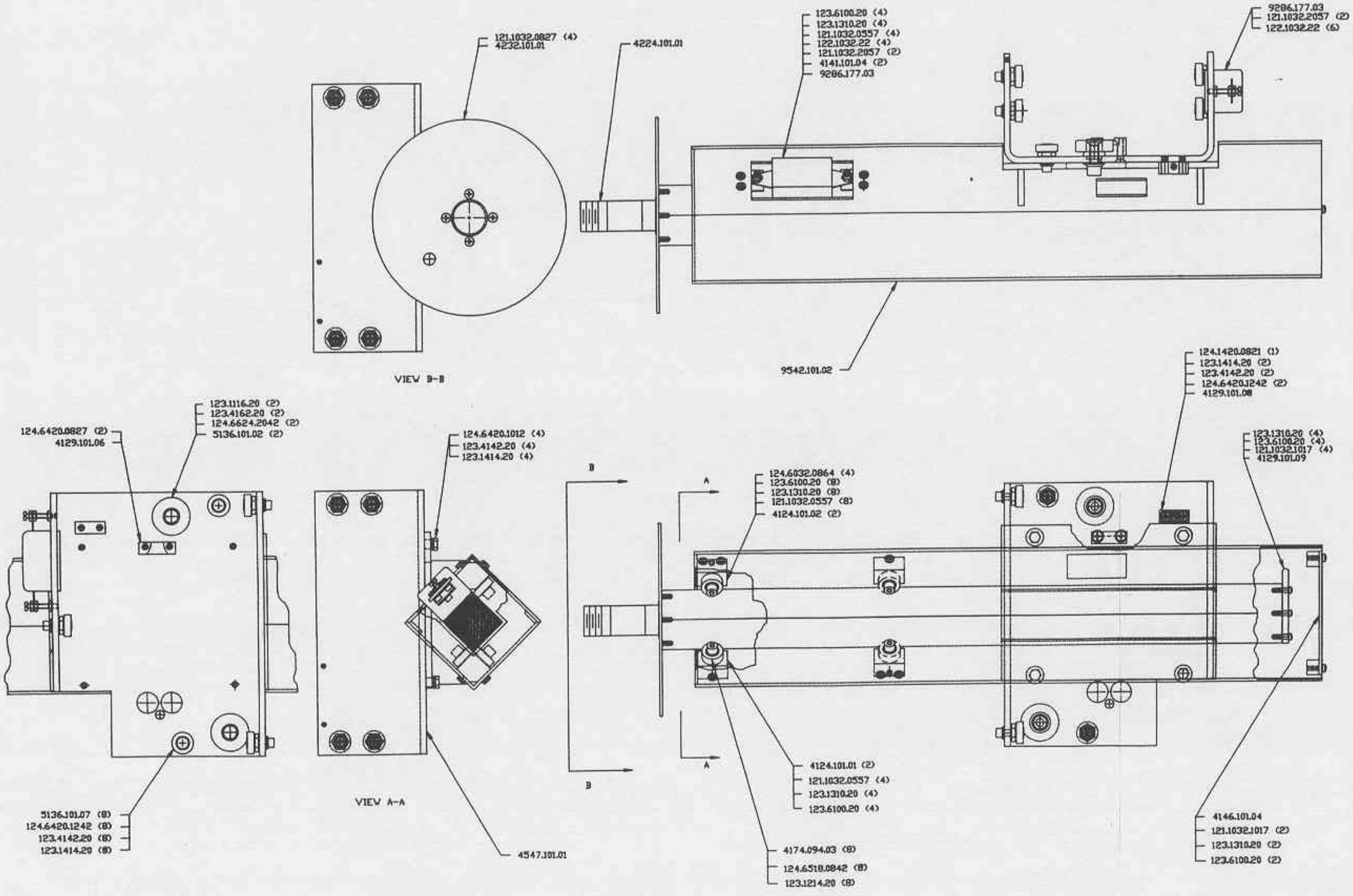

4279.101.01
121.1032.0557 (2)
123.4102.20 (2)
4146.101.06
121.1032.0557 (2)
123.1310.20 (2)
9542.101.04
123.4145.20 (60)
124.6420.1242 (60)
4324.101.03 (3)
4241.101.02 (2)
123.4142.20 (4)
123.1414.20 (4)
124.6420.1242 (4)
5136.101.05 (4)
121.1032.0557 (8)
USE LOCKTITE #222
ON THREADS TIGHTEN
SCREW AND BACK OFF
ONE TURN
A
A
4124.101.08 (4)
9145.101.01 (4)
SECTION A-A

5536.101.01

FIGURE 4-2 MAIN FRAME ASSEMBLY

	Part Number	Description	Quantity		Reference Designators
1.	121.1032.0557	10-32 X 5/16 Pan Steel Philps Screw	12	EA	
2.	123.1310.20	.204Id .438Od .032T Mach Scrw Washr	2	EA	
3.	123.1414.20	17/64I 1/2Od 1/16T Stl Elect.Washer	4	EA	
4.	123.4102.20	#10 Medium Pattern Split Lockwasher	4	EA	
5.	123.4142.20	1/4 Medium Pattern Split Lockwasher	4	EA	
6.	123.4145.20	1/4 Hi-Collar Split Lockwasher	60	EA	
7.	124.6420.1242	1/4-20 X 3/4 Socket Head Cap Screw	64	EA	
8.	4124.101.08	CTC Transport Dolly Fork Scrng Pin	4	EA	
9.	4146.101.06	CTC SID Switch Cam	1	EA	
10.	4241.101.02	CTC Main Frame To Floor Anchor	2	EA	
11.	4279.101.01	CTC Horizontal SID Scale	1	EA	
12.	4324.101.03	CTC 3/4" Square Main Frame Rail	3	EA	
13.	5136.101.05	CTC Dolly Lock Pin & Cable Assembly	4	EA	
14.	9145.101.01	CTC Adjustable Foot Assembly	4	EA	
15.	9542.101.04	CTC Main Frame Weldment Assembly	1	EA	

TABLE 4-1 Parts List for 5536.101.01
CTC Main Frame Assembly


121.1032.0827 (4)
4232.101.01
4224.101.01
123.6100.20 (4)
123.1310.20 (4)
121.1032.0557 (4)
122.1032.22 (4)
121.1032.2057 (2)
4141.101.04 (2)
9286.177.03
9286.177.03
121.1032.2057 (2)
122.1032.22 (6)
VIEW B-B
9542.101.02
124.1420.0821 (1)
123.1414.20 (2)
123.4142.20 (2)
124.6420.1242 (2)
4129.101.08
123.1116.20 (2)
123.4162.20 (2)
124.6624.2042 (2)
5136.101.02 (2)
124.6420.0827 (2)
4129.101.06
124.6420.1012 (4)
123.4142.20 (4)
123.1414.20 (4)
123.1310.20 (4)
123.6100.20 (4)
121.1032.1017 (4)
4129.101.09
B
A
124.6032.0864 (4)
123.6100.20 (8)
123.1310.20 (8)
121.1032.0557 (8)
4124.101.02 (2)
A
B
VIEW A-A
4124.101.01 (2)
121.1032.0557 (4)
123.1310.20 (4)
123.6100.20 (4)
5136.101.07 (8)
124.6420.1242 (8)
123.4142.20 (8)
123.1414.20 (8)
4547.101.01
4174.094.03 (8)
124.6518.0842 (8)
123.1214.20 (8)
4146.101.04
121.1032.1017 (2)
123.1310.20 (2)
123.6100.20 (2)

5536.101.02

FIGURE 4-3 VERTICAL & LATERAL CARRIAGE ASSEMBLY

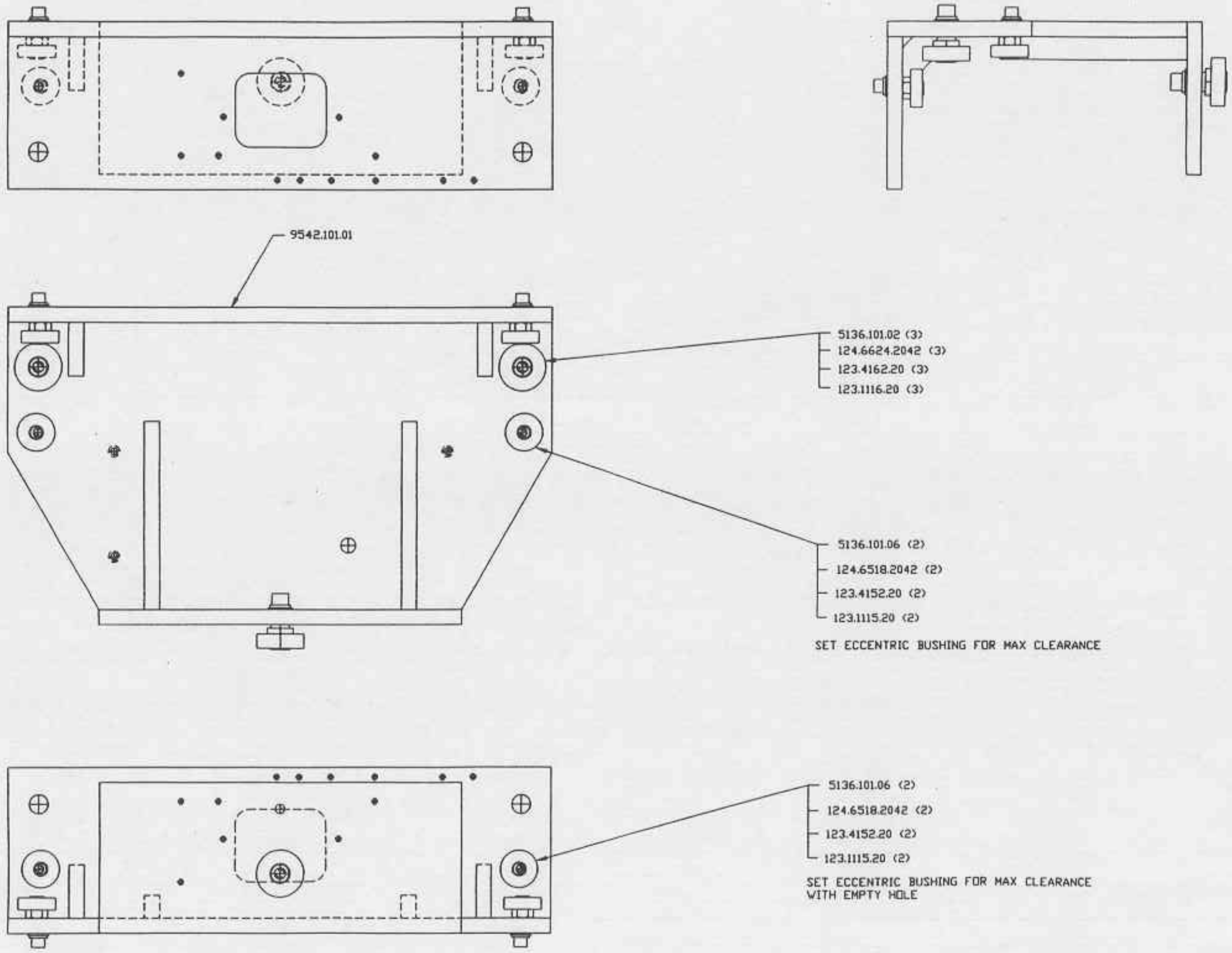
	Part Number	Description	Quantity	Reference Designators
1.	121.1032.0557	10-32 X 5/16 Pan Steel Philps Screw	16 EA	
2.	121.1032.0827	10-32 X 1/2 Flat Steel Philps Screw	4 EA	
3.	121.1032.1017	10-32 X 5/8 Round Steel Phlps Screw	6 EA	
4.	121.1032.2057	10-32 X 1-1/4 Pan Steel Phlps Screw	4 EA	
5.	122.1032.22	10-32 Double Chamfered Hex Nut Stl	10 EA	
6.	123.1214.20	5/16ID 3/40D 1/16T Stl Wrght Washer	8 EA	
7.	123.1310.20	.204Id .4380d .032T Mach Scrw Washr	22 EA	
8.	123.1414.20	17/64I 1/20d 1/16T Stl Elect.Washer	14 EA	
9.	123.4142.20	1/4 Medium Pattern Split Lockwasher	14 EA	
10.	123.6100.20	#10 Internal Tooth Steel Lockwashr	22 EA	
11.	124.1420.0821	1/4-20 X 1/2 Sckt Hd St Scrw Cup Pt	1 EA	
12.	124.6032.0864	10-32x 1/2 FHSCS, Stainless Steel	4 EA	
13.	124.6420.0827	1/4-20 X 1/2 Flat Head Machine Scrw	2 EA	
14.	124.6420.1012	1/4-20 X 5/8 Hex Head Cap Screw	4 EA	
15.	124.6420.1242	1/4-20 X 3/4 Socket Head Cap Screw	10 EA	
16.	124.6518.0842	5/16-18 X 1/2 Socket Head Cap Screw	8 EA	
17.	4124.101.01	CTC Horizontal Tube Bearing Block	2 EA	
18.	4124.101.02	CTC Hrzntl Tube Adjustbl Brng Block	2 EA	
19.	4129.101.06	CTC Vertical Carriage Cable Guide	1 EA	
20.	4129.101.08	CTC Horizontal Arm Adjustment Block	1 EA	
21.	4129.101.09	CTC Tube Cntr Sw Actuator & Stop Pl	1 EA	
22.	4141.101.04	CTC Transverse Lock Bracket	2 EA	
23.	4146.101.04	CTC Horizontal 4" Tube Rear Plate	1 EA	
24.	4174.106.03	29/32 OD 5/16 ID Ball Bearing	8 EA	
25.	4224.101.01	CTC Cross Travel Extension Shaft	1 EA	
26.	4232.101.01	CTC Rotating Lock Disc	1 EA	

. . . continued on next page

TABLE 4-2 Parts List for 5536.101.02
CTC Vertical & Lateral Carriage Asm

	Part Number	Description	Quantity	Reference Designators
27.	4547.101.01	CTC Vertical Carriage	1 EA	
28.	5136.101.02	CTC Cncntrc Rivet Stud & Brng Asm	2 EA	
29.	5136.101.07	CTC Eccntrc Rivet Stud & Brng Asm	8 EA	
30.	9286.177.03	28 Volt Magnet	2 EA	
31.	9542.101.02	CTC 4" Tube & Mntng Plate Weldment	1 EA	

TABLE 4-2 Parts List for 5536.101.02
CTC Vertical & Lateral Carriage Asm


9542.101.01
5136.101.02 (3)
124.6624.2042 (3)
123.4162.20 (3)
123.1116.20 (3)
5136.101.06 (2)
124.6518.2042 (2)
123.4152.20 (2)
123.1115.20 (2)

SET ECCENTRIC BUSHING FOR MAX CLEARANCE

5136.101.06 (2)
124.6518.2042 (2)
123.4152.20 (2)
123.1115.20 (2)

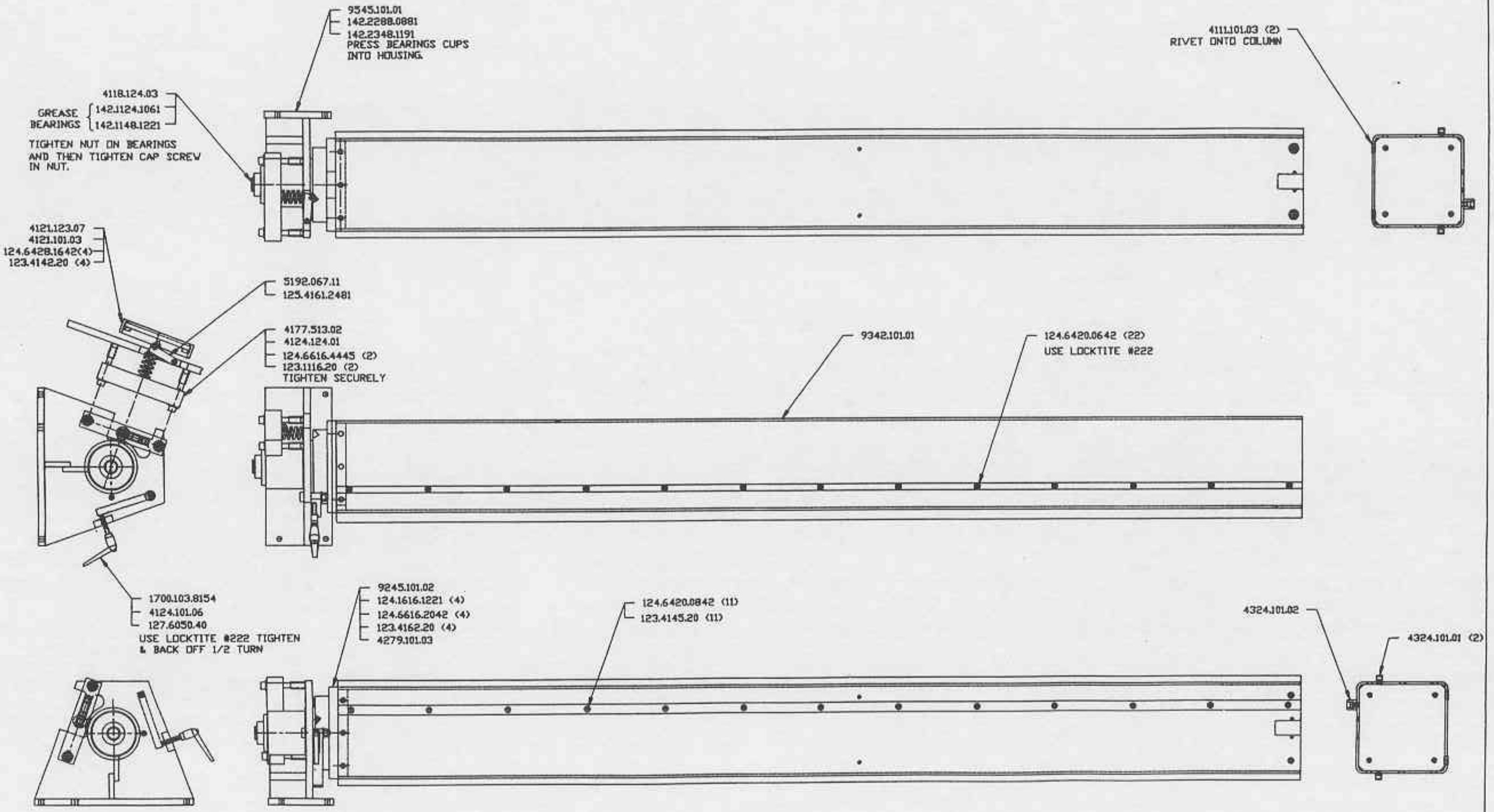
SET ECCENTRIC BUSHING FOR MAX CLEARANCE
WITH EMPTY HOLE

5536.101.05

FIGURE 4-4 HORIZONTAL CARRIAGE ASSEMBLY

	Part Number	Description	Quantity		Reference Designators
1.	123.1115.20	11/32Id 11/16Od 1/16T Stl Sae Washr	4	EA	
2.	123.1116.20	13/32Id 13/16Od 1/16T Stl Sae Washr	3	EA	
3.	123.4152.20	5/16 Medium Pattrn Split Lockwasher	4	EA	
4.	123.4162.20	3/8 Medium Pattern Split Lockwasher	3	EA	
5.	124.6518.2042	5/16-18 X 1-1/4 Socket Hd Cap Screw	4	EA	
6.	124.6624.2042	3/8-24 X 1-1/4 Socket Head Cap Scrw	3	EA	
7.	5136.101.02	CTC Cncntrc Rivet Stud & Brng Asm	5	EA	
8.	5136.101.06	CTC Eccentric Bushing & Brng Asm	4	EA	
9.	9542.101.01	CTC Horizontal Carriage Weldment	1	EA	

TABLE 4-3 Parts List for 5536.101.05
CTC Horizontal Carriage Assembly


9545.101.01
142.2288.0881
142.2348.1191
PRESS BEARINGS CUPS INTO HOUSING.
4111.101.03 (2)
RIVET ONTO COLUMN
4118.124.03
GREASE BEARINGS
142.1124.1061
142.1148.1221
TIGHTEN NUT ON BEARINGS AND THEN TIGHTEN CAP SCREW IN NUT.
4121.123.07
4121.101.03
124.6428.1642(4)
123.4142.20 (4)
5192.067.11
125.4161.2481
4177.513.02
4124.124.01
124.6616.4445 (2)
123.1116.20 (2)
TIGHTEN SECURELY
9342.101.01
124.6420.0642 (22)
USE LOCKTITE #222
1700.103.8154
4124.101.06
127.6050.40
USE LOCKTITE #222 TIGHTEN & BACK OFF 1/2 TURN
9245.101.02
124.1616.1221 (4)
124.6616.2042 (4)
123.4162.20 (4)
4279.101.03
124.6420.0842 (11)
123.4145.20 (11)
4324.101.02
4324.101.01 (2)

5536.101.06

FIGURE 4-5 VERTICAL COLUMN ASSEMBLY

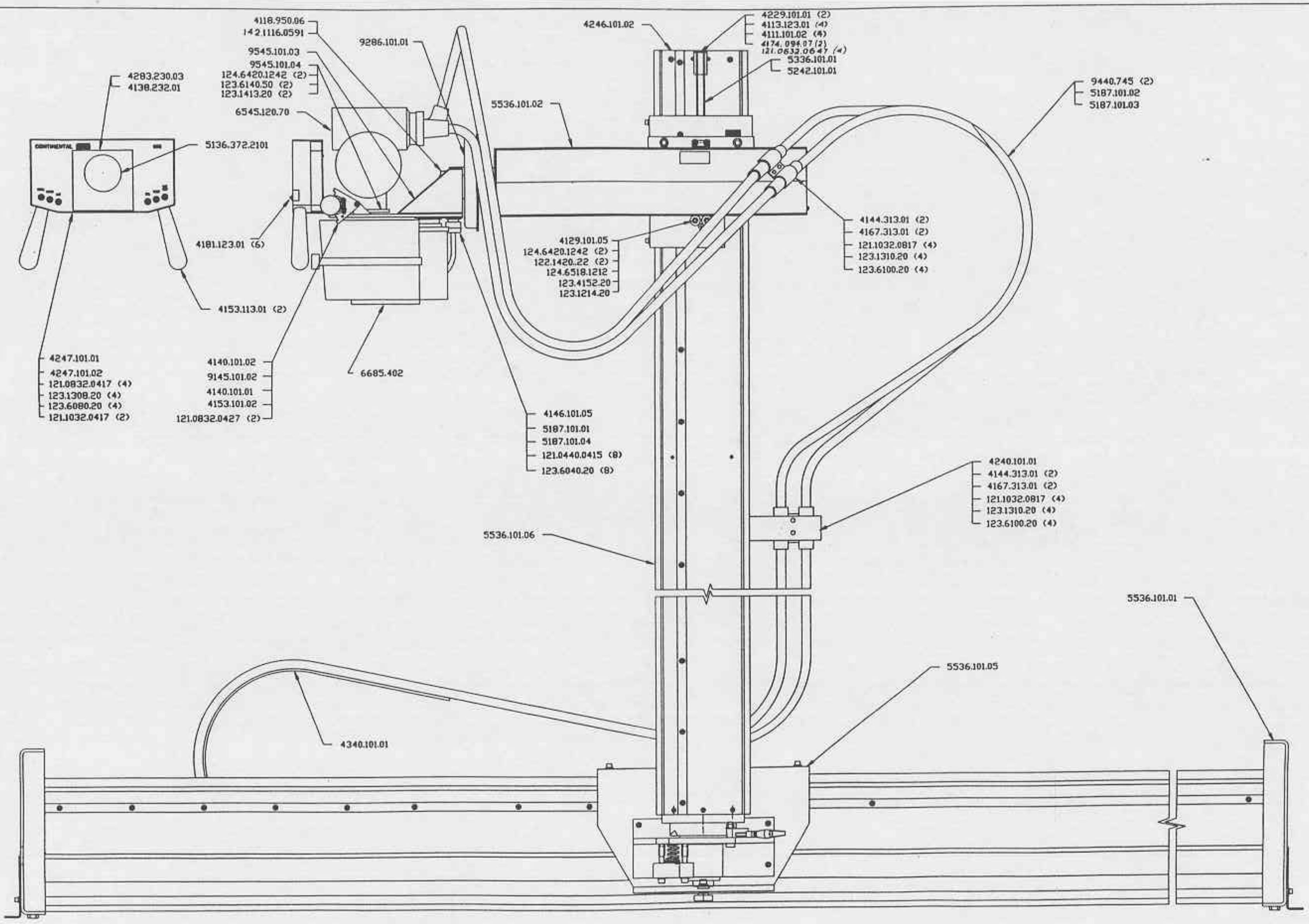
	Part Number	Description	Quantity	Reference Designators
1.	123.1116.20	13/32Id 13/16Od 1/16T Stl Sae Washr	2 EA	
2.	123.4142.20	1/4 Medium Pattern Split Lockwasher	4 EA	
3.	123.4145.20	1/4 Hi-Collar Split Lockwasher	11 EA	
4.	123.4165.20	3/8 Hi-Collar Split Lockwasher	4 EA	
5.	124.1616.1221	3/8-16 X 3/4 Sckt Hd St Scrw Cup Pt	4 EA	
6.	124.6420.0642	1/4-20x 3/8 Soc Hd Cap Screw, Nickl	22 EA	
7.	124.6420.0842	1/4-20 X 1/2 Socket Head Cap Screw	11 EA	
8.	124.6428.1642	1/4-28 X 1 Socket Head Cap Screw	4 EA	
9.	124.6616.2042	3/8-16 X 1-1/4 Socket Head Cap Scrw	4 EA	
10.	124.6616.4445	3/8-16 X 2-3/4 Socket Head Cap Scrw	2 EA	
11.	125.4161.2481	1/4 Od X 3/4 Long .048 Thck Rollpin	1 EA	
12.	127.6060.40	3/8 X 1/2 Stripper Bolt	1 EA	
13.	142.1124.1061	1.375 ID X 1.062 Length Cone	1 EA	
14.	142.1148.1221	1-3/4" ID X 1.216 L Cone	1 EA	
15.	142.2288.0881	2.875 OD X .875 L Cup	1 EA	
16.	142.2348.1191	3.4375 OD X .9375 L Cup	1 EA	
17.	170.0103.8011	Modern Adjstbl Hndl 1/4-20 Tap Hole	1 EA	
18.	4111.101.03	CTC Column Shipping Bushing	2 EA	
19.	4118.124.03	1-14Thd X 1-3/4D X 1/2W Clamp Nut	1 EA	
20.	4121.101.03	CTC Vertical Column Indexing Collar	1 EA	
21.	4121.123.07	Sedgwick II Indexing Ring	1 EA	
22.	4124.101.06	CTC Column Lock Lever	1 EA	
23.	4124.124.01	Seville Spring Tensioner Bar	1 EA	
24.	4177.513.02	1 D X .51 X 3 165 PPI Spring	1 EA	
25.	4324.101.01	CTC 1/2" Square Column Rail	2 EA	
26.	4324.101.02	CTC 3/4" Square Column Rail	1 EA	

. . . continued on next page

TABLE 4-4 Parts List for 5536.101.06
CTC Vertical Column Assembly

	Part Number	Description	Quantity	Reference Designators
27.	5192.067.11	Tubestand Index Roller Assembly	1 EA	
28.	9245.101.02	CTC Column Plate & Shaft Assembly	1 EA	
29.	9342.101.01	CTC Column Weld Assembly	1 EA	
30.	9545.101.01	Tube Stand Pivot Bearing Weldment	1 EA	

TABLE 4-4 Parts List for 5536.101.06
CTC Vertical Column Assembly


4118.950.06
142.1116.0591
9286.101.01
9545.101.03
9545.101.04
124.6420.1242 (2)
123.6140.50 (2)
123.1413.20 (2)
4283.230.03
4138.232.01
6545.120.70
5136.372.2101
CONTINENTAL
5536.101.02
4246.101.02
4229.101.01 (2)
4113.123.01 (4)
4111.101.02 (4)
4174. 094.07 (2)
121.0632.0647 (4)
5336.101.01
5242.101.01
9440.745 (2)
5187.101.02
5187.101.03
4181.123.01 (6)
4153.113.01 (2)
4129.101.05
124.6420.1242 (2)
122.1420..22 (2)
124.6518.1212
123.4152.20
123.1214.20
4144.313.01 (2)
4167.313.01 (2)
121.1032.0817 (4)
123.1310.20 (4)
123.6100.20 (4)
4247.101.01
4247.101.02
121.0832.0417 (4)
123.1308.20 (4)
123.6080.20 (4)
121.1032.0417 (2)
4140.101.02
9145.101.02
4140.101.01
4153.101.02
121.0832.0427 (2)
6685.402
4146.101.05
5187.101.01
5187.101.04
121.0440.0415 (8)
123.6040.20 (8)
4240.101.01
4144.313.01 (2)
4167.313.01 (2)
121.1032.0817 (4)
123.1310.20 (4)
123.6100.20 (4)
5536.101.06
5536.101.01
5536.101.05
4340.101.01

6810.100

FIGURE 4-6 FLOOR-MOUNTED TUBESTAND ASSEMBLY

	Part Number	Description	Quantity	Reference Designators
1.	121.0440.0415	4-40 X 1/4 Round Steel Slottd Screw	8 EA	
2.	121.0440.1067	4-40 X 5/8 Phil Truss Hd Mach Screw	4 EA	
3.	121.0632.0847	6-32 X 1/2 Filstr Steel Phlps Screw	8 EA	
4.	121.0832.0417	8-32 X 1/4 Round Steel Philps Screw	4 EA	
5.	121.0832.0427	8-32 X 1/4 Flat Steel Phillps Screw	2 EA	
6.	121.1032.0417	10-32 X 1/4 Round Steel Phlps Screw	2 EA	
7.	121.1032.0557	10-32 X 5/16 Pan Steel Philps Screw	12 EA	
8.	121.1032.0817	10-32 X 1/2 Round Steel Phlps Screw	12 EA	
9.	121.1032.2057	10-32 X 1-1/4 Pan Steel Phlps Screw	2 EA	
10.	121.1032.3057	10-32 X 1-7/8 Pan Steel Phlps Screw	2 EA	
11.	121.1420.1217	1/4-20 X 3/4 Round Steel Phlp Screw	8 EA	
12.	122.1420.22	1/4-20 Double Chamfered Stl Hex Nut	2 EA	
13.	123.1214.20	5/16ID 3/4OD 1/16T Stl Wrght Washer	1 EA	
14.	123.1308.20	.170Id .375Od .032T Mach Scrw Washr	4 EA	
15.	123.1310.20	.204Id .438Od .032T Mach Scrw Washr	114 EA	
16.	123.1413.20	17/64I 1/2Od 1/32T Stl Elect.Washer	2 EA	
17.	123.4102.20	#10 Medium Pattern Split Lockwasher	12 EA	
18.	123.4152.20	5/16 Medium Pattrn Split Lockwasher	1 EA	
19.	123.4165.20	3/8 Hi-Collar Split Lockwasher	4 EA	
20.	123.6040.20	#4 Internal Tooth Steel Lockwasher	8 EA	
21.	123.6080.20	#8 Internal Tooth Steel Lockwasher	4 EA	
22.	123.6100.20	#10 Internal Tooth Steel Lockwashr	114 EA	
23.	123.6140.20	1/4 Internal Tooth Steel Lockwasher	2 EA	
24.	124.6420.1242	1/4-20 X 3/4 Socket Head Cap Screw	4 EA	
25.	124.6518.1212	5/16-18 X 3/4 Hex Head Cap Screw	1 EA	
26.	127.6060.30	3/8x 3/8 (5/16-18 Thd)Shoulder Bolt	1 EA	

. . . continued on next page

TABLE 4-5 Parts List for 6810.100.
Military Floor-Mounted Tube Stand

	Part Number	Description	Quantity		Reference Designators
27.	127.6060.5202	3/8x5/8 Stripper Bolt, With Nyloc	1	EA	
28.	127.6080.80	1/2x 1 (3/8-16 Thd) Shoulder Bolt	2	EA	
29.	135.3301.2002	3/16" Heat Shrink Tubing	3	FT	
30.	142.1116.0591	1-1/4 ID X 19/32 Long Cone	2	EA	
31.	142.2231.0581	.578 W X 2.31 OD Cup	2	EA	
32.	4111.101.02	CTC Tubestnd Pulley Bearing Bushing	4	EA	
33.	4113.123.01	Sedgwick Counterweight Pulley	4	EA	
34.	4118.950.06	2 D 1-1/4 12 Clamp Nut	1	EA	
35.	4121.101.02	CTC Pitch Lock Compression Member	1	EA	
36.	4129.101.05	CTC Cntrwght Cable Equalizer Bar	1	EA	
37.	4129.101.11	CTC Pitch Lock Clamp Bar	1	EA	
38.	4138.232.01	4.5 Square Fan Finger Guard	1	EA	
39.	4140.062.03	MXT 90/15 Cable Band Spprt Bracket	5	EA	
40.	4140.062.04	MXT 90/15 Cbl Band End Spprt Brckt	1	EA	
41.	4140.101.01	CTC Pitch Lock Floating Plate	1	EA	
42.	4140.101.02	CTC Pitch Lock Disc, Foot And Side	1	EA	
43.	4140.851.01	Duocon-S VDT Switch Actuator	2	EA	
44.	4141.101.03	CTC Tube Center Switch Mntng Brckt	1	EA	
45.	4141.101.05	CTC High Voltage Clamp Bracket	5	EA	
46.	4141.101.06	CTC Vertical Carriage Shipping Brct	2	EA	
47.	4144.313.01	Cable Clamp	6	EA	
48.	4145.101.01	CTC CID Switch Mntng Brckt Weldment	1	EA	
49.	4146.101.03	CTC Tube Center Switch Mntng Plate	1	EA	
50.	4146.101.05	CTC Coll- Rotor Cbl Connector Brckt	1	EA	
51.	4146.101.06	CTC SID Switch Cam	2	EA	
52.	4146.101.07	CTC Horizontal SID Pointer	1	EA	

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TABLE 4-5 Parts List for 6810.100.
Military Floor-Mounted Tube Stand

	Part Number	Description	Quantity		Reference Designators
53.	4147.101.01	CTC Vertical SID Pointer	1	EA	
54.	4147.101.02	CTC Column Angulation Pointer	1	EA	
55.	4147.101.03	CTC Pitch Lock	1	EA	
56.	4153.101.02	1 3/4 Inch Dia. Black Knob	1	EA	
57.	4153.113.01	Smooth Tapered Grey Handle	2	EA	
58.	4167.313.01	1.375 ID X 6" X.065W Knife Cut Tube	6	EA	
59.	4167.313.03	HV Cable Center Support, Light Grey	8	EA	
60.	4174.094.07	29/32 OD 7/16 ID Ball Bearing	2	EA	
61.	4179.234.03	MXR-350 Manufactured Label	1	EA	
62.	4179.234.09	MXR-350 Serial Number Label	1	EA	
63.	4181.123.01	Sedgwick Centering Switch	6	EA	
64.	4181.851.01	SPDT Roller V3L Micro Switch	3	EA	
65.	4229.101.01	CTC Cntrwght Pulley Mounting Plate	2	EA	
66.	4240.101.01	CTC Cable Band Support Bracket	1	EA	
67.	4240.101.02	CTC Mntng Brckt,Cable Support Band	1	EA	
68.	4241.101.06	CTC Longintunal Shipping Bracket	1	EA	
69.	4246.101.02	CTC Vertical Column Cover Plate	1	EA	
70.	4247.101.01	CTC Control Panel Fan Mounting	1	EA	
71.	4247.101.02	CTC Sw Cntrl & Angulation Dial Pnl	1	EA	
72.	4247.101.03	CTC Cover Box, Electric Lock	2	EA	
73.	4247.101.04	CTC Cover Box, Elctrc Lock & SID Sw	1	EA	
74.	4247.101.05	CTC Cover Box Horz. SID Switch	1	EA	
75.	4247.101.06	CTC Transverse Center Switch Cover	1	EA	
76.	4279.101.01	CTC Horizontal SID Scale	1	EA	
77.	4279.101.02	CTC Vertical SID Scale	1	EA	
78.	4279.101.03	Column Angulation Scale	1	EA	

. . . continued on next page

TABLE 4-5 Parts List for 6810.100.
Military Floor-Mounted Tube Stand

	Part Number	Description	Quantity	Reference Designators
79.	4283.230.03	115 Volt .24 Amp 115Cfm Boxer Fan	1 EA	
80.	4340.101.01	CTC Cable Support Band	1 EA	
81.	5136.372.2101	Prescott Blue Tilt Indicator Asm	1 EA	
82.	5187.101.0110	OT Collimator Cable	1 EA	
83.	5187.101.0410	OT Tube Rotor Cable	1 EA	
84.	5196.101.01	CTC Installation Kit	1 EA	
85.	5236.101.01	CTC Cntrwght Box & Brng Strip Asm	1 EA	
86.	5285.101.03	CTC Roll Lock Assembly	1 EA	
87.	5336.101.01	CTC Counterweight Cable Assembly	1 EA	
88.	5387.101.01	CTC High Voltage & Main Cable Asm	1 EA	
89.	5487.101.01	CTC Cable Assembly	1 EA	
90.	5536.101.01	CTC Main Frame Assembly	1 EA	
91.	5536.101.02	CTC Vertical & Lateral Carriage Asm	1 EA	
92.	5536.101.05	CTC Horizontal Carriage Assembly	1 EA	
93.	5536.101.06	CTC Vertical Column Assembly	1 EA	
94.	9145.101.02	CTC Pitch Lock Bar & Rod Weldment	1 EA	
95.	9545.101.03	CTC Roll Pivot Wldmnt, Diamond Tube	1 EA	
96.	9545.101.04	CTC Tube & Cntrl Box Mntng Weldment	1 EA	

TABLE 4-5 Parts List for 6810.100.
Military Floor-Mounted Tube Stand

CHAPTER 9

AUXILIARY BOX

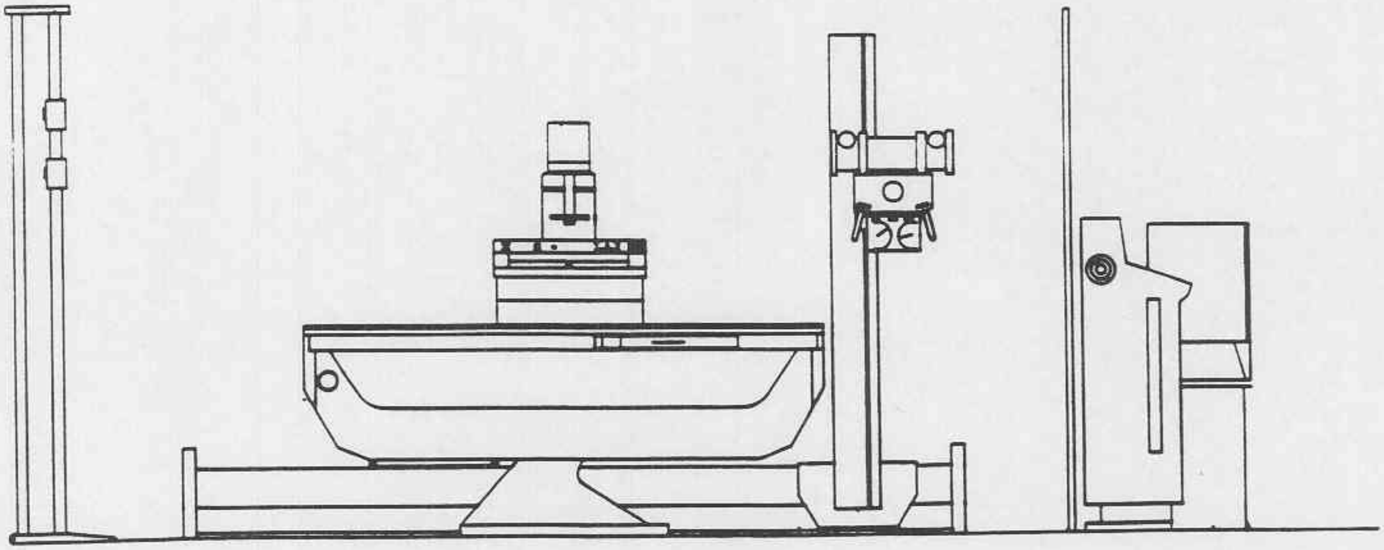


TABLE OF CONTENTS

CHAPTER 9 - AUXILIARY BOX

SECTION NUMBER	DESCRIPTION	PAGE NUMBER
SECTION 1 - GENERAL		**1-1**
1.1 SCOPE		1-1
1.2 HIGH VOLTAGE CABLES		1-1
1.3 AUXILIARY BOX SIGNALS DESCRIPTION		1-3
SECTION 2 - WIRING DIAGRAM AND PARTS LISTS		**2-1**

LIST OF FIGURES

FIGURE NUMBER	DESCRIPTION	PAGE NUMBER
1-1	AUXILIARY CIRCUIT BOX	1-2
2-1	AUXILIARY BOX WIRING DIAGRAM	2-2
2-2	TABLE TUBESTAND AUXILIARY BOX ASSEMBLY	2-3
2-3	LAYOUT FOR 6284.062.03 MXT 90/15 MAGNETIC LOCK POWER SUPPLY PCB	2-7
2-4	SCHEMATIC FOR 6284.062.03 MXT 90/15 MAGNETIC LOCK POWER SUPPLY PCB	2-9
2-5	LAYOUT FOR 6284.062.05 MXT 90/15 MOTOR CARRIAGE DRIVE PCB	2-10
2-6	SCHEMATIC FOR 6284.062.05 MXT 90/15 MOTOR CARRIAGE DRIVE PCB	2-12
2-7	LAYOUT FOR 6284.062.06 MXT 90/15 VARI-SPEED TILT CONTROL PCB	2-13
2-8	SCHEMATIC FOR 6284.062.06 MXT 90/15 VARI-SPEED TILT CONTROL PCB	2-15
2-9	LAYOUT FOR 6284.062.07 MXT 90/15 TABLE TILT CONTROL PCB	2-16
2-10	SCHEMATIC FOR 6284.062.07 MXT 90/15 TABLE TILT CONTROL PCB	2-18

CHAPTER 9 - AUXILIARY BOX

SECTION 1 - GENERAL

1.1 SCOPE

The Auxiliary Cabinet/Auxiliary Circuit Box (FIGURE 1-1) serves a central connection location for the CS-8952 Field Deployable X-ray System. It is mounted on the top of the MXR-350 Generator, High Voltage Transformer. **No installation, other than that required for the high voltage transformer, is necessary.**

It includes two (2) DC power supplies. One (1) of them provides operating voltages for the spot film device, the other for the collimator logic circuitry.

The spot film device power supply is protected against overloads by a 10 Amp fuse. The power supply output voltages of 115VAC, 79VDC, and 24VDC are also protected by 1Amp, 7Amp and 3Amp slow blow fuses, respectively.

The tubestand also receives its operating power from a transformer in the auxiliary cabinet. All output voltages are fused to protect the circuits that they power.

1.2 HIGH VOLTAGE CABLES

Two (2) pairs of high voltage cables for connecting the over-table and under-table x-ray tubes to the high voltage transformer are supplied with the system in box 1. One (1)pair of these cables is 30 feet long and the other 35 feet. The 30-foot cables connects the over-table tube, on the tubestand to the high voltage transformer while the 35-foot cables connect the under-table tube to the high voltage transformer.

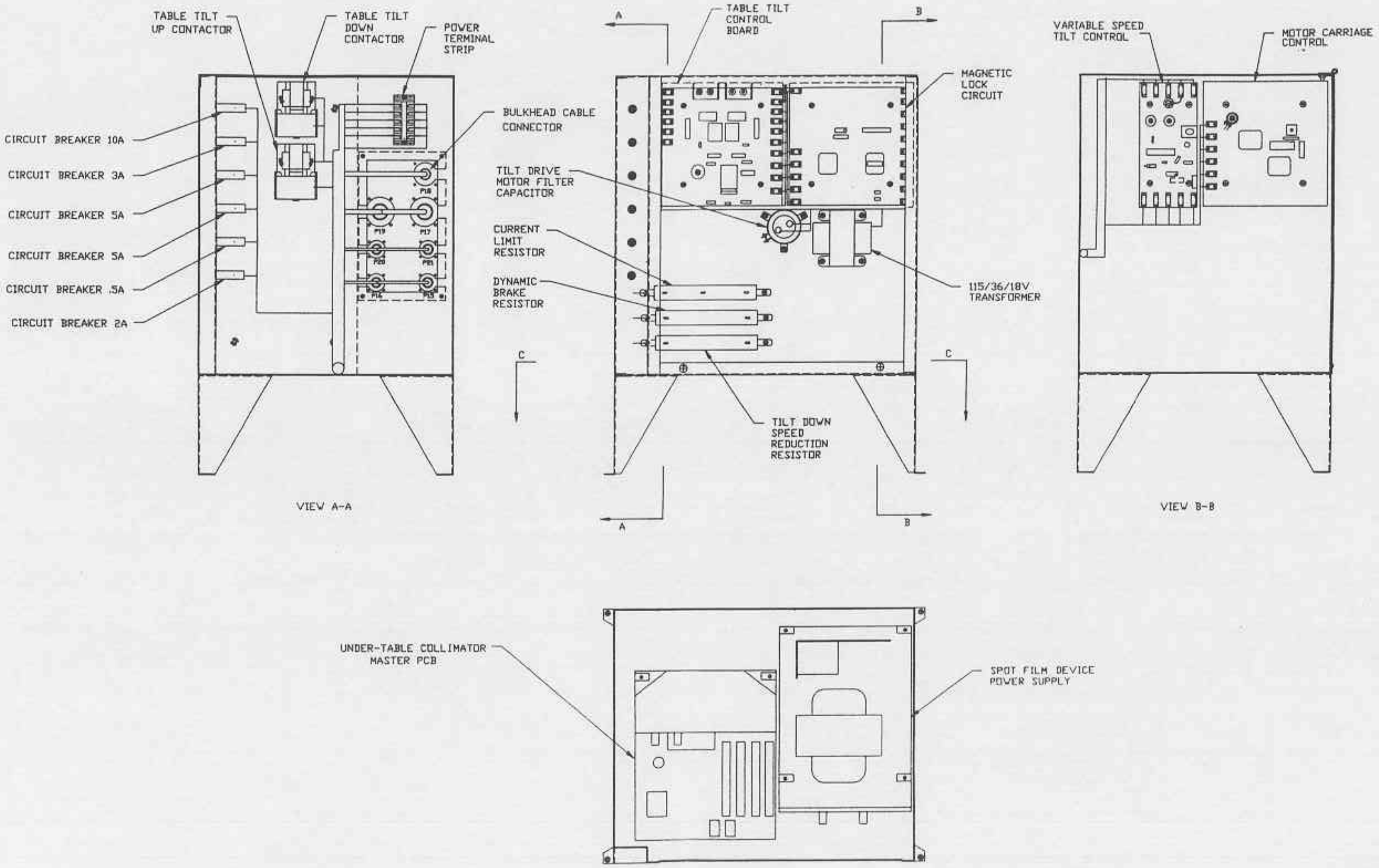


TABLE TILT UP CONTACTOR
TABLE TILT DOWN CONTACTOR
POWER TERMINAL STRIP
BULKHEAD CABLE CONNECTOR
CIRCUIT BREAKER 10A
CIRCUIT BREAKER 3A
CIRCUIT BREAKER 5A
CIRCUIT BREAKER 5A
CIRCUIT BREAKER .5A
CIRCUIT BREAKER 2A
P18
P19
P17
P20
P21
P14
P15
VIEW A-A
A
TABLE TILT CONTROL BOARD
B
MAGNETIC LOCK CIRCUIT
TILT DRIVE MOTOR FILTER CAPACITOR
CURRENT LIMIT RESISTOR
DYNAMIC BRAKE RESISTOR
115/36/18V TRANSFORMER
C
C
TILT DOWN SPEED REDUCTION RESISTOR
A
B
VARIABLE SPEED TILT CONTROL
MOTOR CARRIAGE CONTROL
VIEW B-B
UNDER-TABLE COLLIMATOR MASTER PCB
SPOT FILM DEVICE POWER SUPPLY
VIEW C-C

FIGURE 1—1 AUXILIARU CIRCUIT BOX

1.3 AUXILIARY BOX SIGNALS DESCRIPTION

NOTE

For information detailing "source and "destination"
of these signals see Chapter 4, Section 2.2

115V - 115 VAC
115V(N) - 115 VAC neutral
115VR - 115 VAC after circuit breaker CB5
18V - 18 VAC (18V - 36VR)
36V - 36 VAC (36V - 36VR)
36VR - 36 VAC return
AA1 - Tilt armature power
AA2 - Tilt armature power
AB1 - Tilt power to tilt up and down relays
AEC - Tilt speed control for SFD
AEC1 - Tilt speed control slow-down through delay-on-operate relay
AES - Tilt Speed Control
ANS - Negative tilt armature voltage
APL - Tilt power to SCR's before surge resistor
APP - Positive tilt armature power
ASE - Lock transformer secondary (24 VAC)
ASL - Lock transformer secondary (24 VAC)
AVF - Tilt power to SCR's after surge resistor
AVS - 115 VAC source for tilt speed control
B2 - Bucky Expose signal out
CAN - Carriage drive to head end
CAP - Carriage armature voltage positive
CFR - Carriage drive to foot end
CHR - Carriage drive to head end
DLD - Source for lateral and longitudinal locks before Re-1-AL relay
DLL - Source for lateral and longitudinal locks after RE-1-AL relay
DLN - Lock common
DLP - Lock power source
DLP(R) - DLP signal after circuit breaker CB6
DPG - Gate pulse to tilt control SCR's
G - Ground
KVA - 115 VAC to KVC via Re-1-LC for compression lock
KVC - 115 VAC source to compression lock on spot film tower
LL - Tilt down relay top drive interlock
LR - Tilt up relay top drive interlock
N - Neutral
RL - 115 VAC with SFD cassette forward to activate Re-1-LC

1.3 AUXILIARY BOX SIGNALS DESCRIPTION (continued)

TD	-	Tilt down signal from tilt contactor
TDE	-	Tilt down signal from tilt switch
TEE	-	Horizontal Stop Delay Adjust
THC	-	Horizontal Stop Capacitor bleed
THL	-	Horizontal Stop Switch Common
TLR	-	Tilt down relay from Trendelenberg limit switch
TP	-	Table power 115 VAC unfused
TPA	-	Carriage assist start switch common
TPF	-	Table power 115 VAC fused
TRR	-	Tilt up relay
TU	-	Tilt up signal to tilt contactor
TUE	-	Tilt up signal from tilt switch
TVD	-	Top drive control source (115 VAC)

SECTION 2 - WIRING DIAGRAM AND PARTS LISTS

NOTE

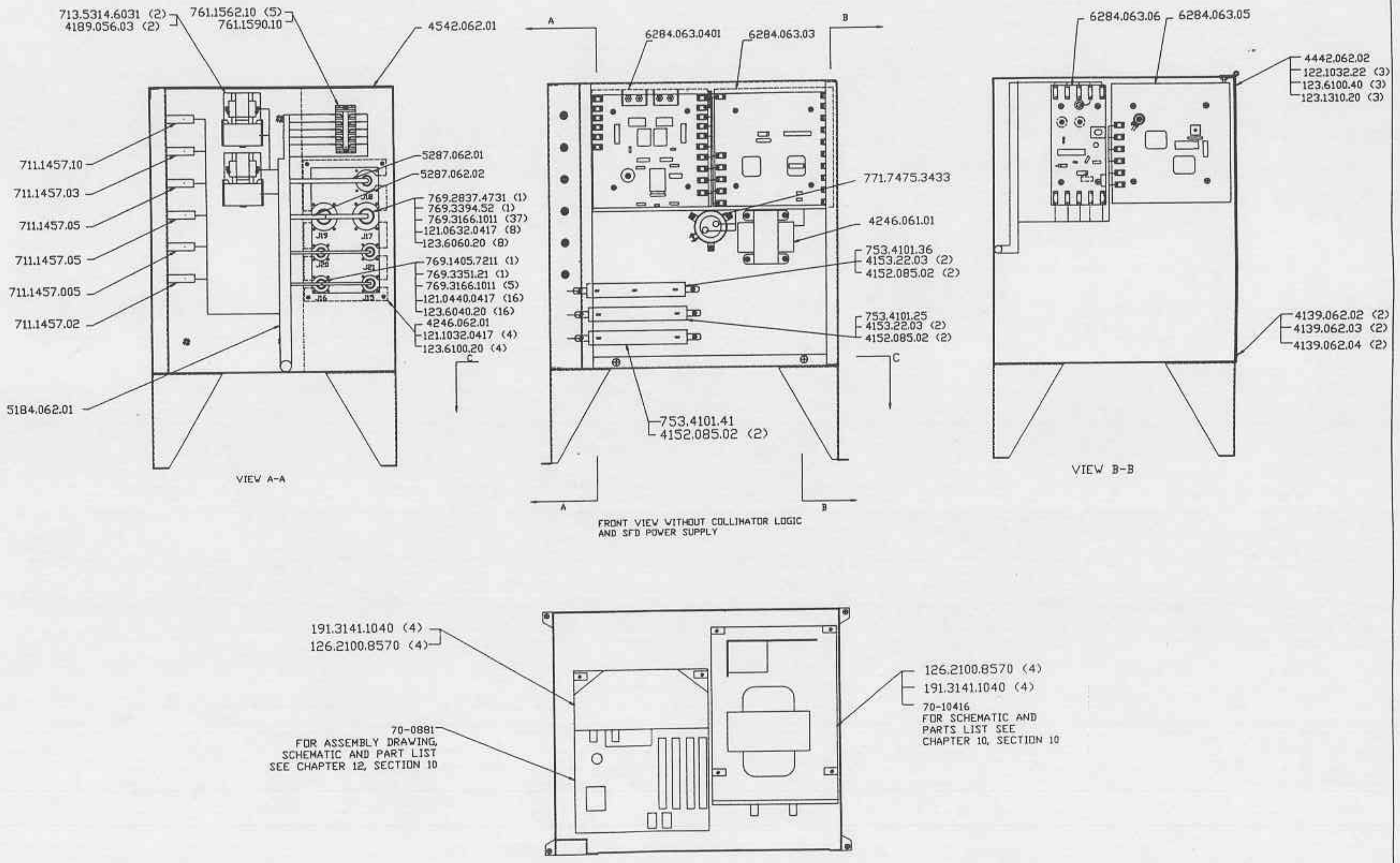
This section printed on one side of page, only.

WIRES DESIGNATION
WIRES DESTINATION
WIRES COLOR CODE
CB-1
TP
TPF
CB-2
TPA
CB-3
TVD
CB-4
ASE
ASL
CB-5
115V
115VR
CB-6
DLP
DLPR
K1
K2
TLR
LL
LR
TRR
AA1
AA2
AB1
ANS
APP
APL
TPF
CSR
CSF
TS
115V
115VN
G
DLP
DLN
J18*
SFD P.S.
J19*
J17*
J20*
J21*
J16*
J15*
MXT 90/15
TABLE TILT
CONTROL PCB
6284.062.07
(TTC)
MXT 90/15
MAGNETIC LOCK
POWER SUPPLY PCB
6284.062.03
(MLC)
MXT 90/15
VARI-SPEED
TILT CONTROL
PCB
6284.062.06
(VSC)
R4
5.6K/.5W
MXT 90/15
MOTOR CARRIAGE
DRIVE PCB
6284.062.05
(MCC)
C1
TR-1
36VAC
36V
18V
36VR
18VR
R1
R2
R3
AVF
APL
APP
AB1
AA2
COLLIMATOR LOGIC
6488.000
(CL)
SFD
POWER SUPPLY
6488.100
(SFD P.S.)
J18
J21
J20
J15
J19
TS
5287.062.02
5287.062.02
5287.062.01
G

NO.	DESCRIPTION CONNCT	 PINS	 CLAMP	COLOR CODE	DESIGNAT	DESTINAT.	
J15-1	7 CNT. RECEPTACLE 208715-1 769.1407.7151	18GA PINS 66099-1 769.3266.0991	STRAIN REL. 208945-5 769.3394.55	WHT	$115V_N$	TS	18GA WIRES
J15-2				BLK	115V	TS	
J15-3				GRN	G	TS	
J15-5		22GA PINS 66400-2 769.3266.4002		BLK	HOLD	CL	4 CND. 22GA CABLE
J15-6				RED	EXP	CL	
J16-1	5 CONT. RECEPTACLE 208721-1 769.1405.7211	18GA SOCKETS 66101-1 769.3166.1011	STRAIN REL. 208945-5 769.3394.55	WHT	$115V_N$	TS	18GA WIRES
J16-2				BLK	$115V_R$	CB-5	
J16-3				ORG	DLP_R	CB-6	
J16-4				RED	DLN	TS	
J16-5				GRN	G	TS	
J17-1	37 CONTAVT BULKHEAD RECEPTACLE 208473-1 (769.2837.4731)	16-18 AWG BULKHEAD SOCKETS 66101-1 (769.3166.1011)	BULKHEAD STRAIN RELIEF FOR SHELL 23 206512-1 (769.335121)	RED	TPA	CB-2	18 AWG SINGLE WIRES
J17-2				BLK	CHR	MLC	
J17-3				RED	CAP	MCC	
J17-4				ORG	CFR	MLC	
J17-5				VIO	CAN	MCC	
J17-6					NOT USED		
J17-7					NOT USED		
J17-8					NOT USED		
J17-9				RED	DLD	MLC	
J17-10				BLU	DLL	MLC	
J17-11				VIO	DLN	MLC	
J17-12				GRY	DLP	MLC	
J17-13				BRN	TPF	TTC	
J17-14				WHT	N	TTC	
J17-15				YEL	TEE	TTC	
J17-16				ORG	THL	TTC	
J17-17				RED	THC	TTC	
J17-18				VIO	TUE	TTC	
J17-19				BLK	TDE	TTC	
J17-20				BLU	TU	TTC	
J17-21				BLK	TD	TTC	
J17-25				BRN	AEC	VSC	
J17-26				BLU	AES	VSC	
J17-27				VIO	TVD	CB-3	
J17-28				BLU	TP	CB-1	
J17-29				YEL	TLR	K1	
J17-30					NOT USED		
J17-31				BLK	AA1	K2	
J17-32				BLK	LL	K1	
J17-33				VIO	LR	K2	
J17-34				RED	AA2	K1	
J17-35				BLU	TRR	K2	
J17-36					NOT USED		
J17-37				GRN	G	TS	
J18-1	14 CONT BULKHEAD RECEPTACLE 208487-1 (769.2214.4871)	18 AWG SOCKETS 66101-1 (769.3166.1011)	BULKHEAD STRAIN RELIEF FOR SHELL 17 206322-1 (769.3332.21)	GRN	CH GND	SFD PS	10 CND. 18 AWG SHIELDED CABLE
J18-2				BLK	115V	SFD PS	
J18-3				ORG	79VDC	SFD PS	
J18-4				BLU	LG GND	SFD PS	
J18-5				VIO	28VAC	SFD PS	
J18-6				BRN	0 VAC	SFD PS	
J18-7				WHT	0 VAC	SFD PS	
J18-8				RED	24VDC	SFD PS	
J18-9				GRY	LG GND	SFD PS	
J18-11				SHLD		SFD PS	
J18-10		22GA PINS 66400-2 769.3266.4002		BLK		CL	4 CND. 24 AWG SHLD. CBL.
J18-12				RED		CL	
J18-13				GRN		CL	
J18-14				WHT		CL	
J19-1	37 CONT. BULKHEAD RECEPTACLE 208473-1 (769.2837.4831)	20-22 AWG BULKHEAD SOCKETS 66399-2 (769.3166.3992)	BULKHEAD STRAIN RELIEF FOR SHELL 23 206138-1 (769.3313.81)	GRN/WHT	C=-90°	CL	40 COND. 24 AWG SHIELDED CABLE
J19-2				RED/GRN	C=+90° T=+90°	CL	
J19-3				WHT/RED	C=+90°	CL	
J19-4				WHT	STERO/TOMO	CL	
J19-5				BLU/RED	72'SID	CL	
J19-6				RED/WHT/GRN	C=0°,T=0°	CL	
J19-7				WHT/RE/ORG	IR TRUE	CL	
J19-8				GRN	VIRL	CL	
J19-9				RED/BLK	GND	CL	
J19-10				BLK/RED	GND	CL	
J19-13				BLU/WHT	TBL L SID	CL	
J19-14				BLU/BLK WHT	40'SID	CL	
J19-15				ORG/BLK/GRN	VERT SID	CL	
J19-16				RED/WHT	TBL R SID	CL	
J19-17				ORG/GRN	LG GND	CL	
J19-18				BLK/WHT	LG GND	CL	
J19-19				BLK JUMP.	+15V	CL	
J19-20				BLK	+15V	CL	
J19-21				BLK/RED GRN	EXP REL RLY	CL	
J19-22				BLU	C=-90° T=-90°	CL	
J19-23				GRN/BLK/ORG	VALL L/R SID	CL	
J19-24				BLU/WHT/ORG	TILT C=0°	CL	
J19-25				BLK/WHT/ORG	VSID OUT	CL	
J19-26				GRN/BLK	VIRC	CL	
J19-28				SHLD		CL	
J19-29				ORG/BLK/WHT	28VDC	CL	
J19-30				WHT/RED/BLU	27VAC	CL	
J19-31				WHT/BLK/GRN	27VAC	CL	
J19-32				RED/BLK/GRN	27VAC	CL	
J19-33				BLK/WHT/GRN	27VAC	CL	
J19-34				BLK/WHT/RED	0 VAC	CL	
J19-35				RED/BLK/WHT	0 VAC	CL	
J19-36				WHT/BLK/RED	0 VAC	CL	
J19-37				WHT/RED/GRN	0 VAC	CL	
J20-1	7 CONT. BULKHD. RECEPTACLE 208715-1 (769.1407.7151)	20-22 AWG PINS 66400-2 (769.3266.4002)	BULKHEAD STRAIN RELIEF 208945-5 (769.3394.55)	BLK		CL	4 COND. 24 AWG SHIELDED CABLE
J20-2				WHT		CL	
J20-3				RED		CL	
J20-4				GRN		CL	
J20-5				NOT USED			
J20-6				NOT USED			
J20-7				SHLD		CL	
J21-1	7 CONT. BULKHD. RECEPTACLE 208715-1 (769.1407.7151)	20-22 AWG PINS 66400-2 (769.3266.4002)	BULKHEAD STRAIN RELIEF 208945-5 (769.3394.55)	BLK	TS2-10	CL	4 COND. 24 AWG SHIELDED CABLE
J21-2				WHT	TS2-9	CL	
J21-3				NOT USED			
J21-4				GRN	TS2-5	CL	
J21-5				RED	TS2-6	CL	
J21-6				NOT USED		CL	
J21-7				NOT USED			

* - SEE CHART FOR CABLES
AND WIRES CONNECTIONS
ALL CONNECTORS ARE SHOWN FROM THE BACK SIDE

FIGURE 2-1 AUXILIARY BOX WIRING DIAGRAM


713.5314.6031 (2)
4189.056.03 (2)
761.1562.10 (5)
761.1590.10
4542.062.01
711.1457.10
711.1457.03
711.1457.05
711.1457.05
711.1457.005
711.1457.02
5184.062.01
5287.062.01
5287.062.02
769.2837.4731 (1)
769.3394.52 (1)
769.3166.1011 (37)
121.0632.0417 (8)
123.6060.20 (8)
769.1405.7211 (1)
769.3351.21 (1)
769.3166.1011 (5)
121.0440.0417 (16)
123.6040.20 (16)
4246.062.01
121.1032.0417 (4)
123.6100.20 (4)
J18
J19
J17
J20
J21
J16
J15
A
B
C
6284.063.0401
6284.063.03
771.7475.3433
4246.061.01
753.4101.36
4153.22.03 (2)
4152.085.02 (2)
753.4101.25
4153.22.03 (2)
4152.085.02 (2)
753.4101.41
4152.085.02 (2)
6284.063.06
6284.063.05
4442.062.02
122.1032.22 (3)
123.6100.40 (3)
123.1310.20 (3)
4139.062.02 (2)
4139.062.03 (2)
4139.062.04 (2)
191.3141.1040 (4)
126.2100.8570 (4)
70-0881
FOR ASSEMBLY DRAWING,
SCHEMATIC AND PART LIST
SEE CHAPTER 12, SECTION 10
126.2100.8570 (4)
191.3141.1040 (4)
70-10416
FOR SCHEMATIC AND
PARTS LIST SEE
CHAPTER 10, SECTION 10

VIEW A-A

FRONT VIEW WITHOUT COLLIMATOR LOGIC
AND SFD POWER SUPPLY

VIEW B-B

VIEW C-C

5785.062.01

FIGURE 2-2 TABLE TUBESTAND AUXILIARY BOX ASSEMBLY

	Part Number	Description	Quantity		Reference Designators
1.	121.0440.0417	4-40 X 1/4 Round Steel Philps Screw	20	EA	
2.	121.0632.0417	6-32 X 1/4 Round Steel Philps Screw	8	EA	
3.	121.0632.0657	6-32 X 3/8 Pan Steel Phillips Screw	9	EA	
4.	121.0832.0617	8-32 X 3/8 Round Steel Philps Screw	30	EA	
5.	121.1032.0417	10-32 X 1/4 Round Steel Phlps Screw	4	EA	
6.	122.0632.22	6-32 Double Chamfered Hex Steel Nut	9	EA	
7.	122.1032.22	10-32 Double Chamfered Hex Nut Stl	3	EA	
8.	123.1308.20	.170Id .3750d .032T Mach Scrw Washr	30	EA	
9.	123.1310.20	.204Id .4380d .032T Mach Scrw Washr	3	EA	
10.	123.1413.20	17/64I 1/20d 1/32T Stl Elect.Washer	4	EA	
11.	123.4142.20	1/4 Medium Pattern Split Lockwasher	4	EA	
12.	123.6040.20	#4 Internal Tooth Steel Lockwasher	20	EA	
13.	123.6060.20	#6 Internal Tooth Steel Lockwasher	8	EA	
14.	123.6080.20	#8 Internal Tooth Steel Lockwasher	30	EA	
15.	123.6100.20	#10 Internal Tooth Steel Lockwashr	3	EA	
16.	124.6420.0812	1/4-20 X 1/2 Hex Head Cap Screw	4	EA	
17.	126.2100.8570	10B X 1/2 Phil Pan Head Steel Screw	8	EA	
18.	129.6120.7731	1/8"ODx.212L Domed Pop Rivet	4	EA	
19.	191.3141.1040	10Z Type U Tinnerman Nut	8	EA	
20.	4139.062.02	Southco #82 Clip On Receptacle	2	EA	
21.	4139.062.03	Southco #82 Stud, Oval Hd Ph Recess	2	EA	
22.	4139.062.04	Southco #82 Split-Ring Type Retainr	2	EA	
23.	4152.085.02	Resistor Standoff #12	6	EA	
24.	4153.222.03	Slide Band And Knob Asm, 100W Res	3	EA	
25.	4179.234.09	MXR-350 Serial Number Label	1	EA	
26.	4182.193.18	2 Way Tab Connector	1	EA	

. . . continued on next page

TABLE 2-1 Parts List for 5785.062.01
Table Tubestand Auxiliary Box Asm

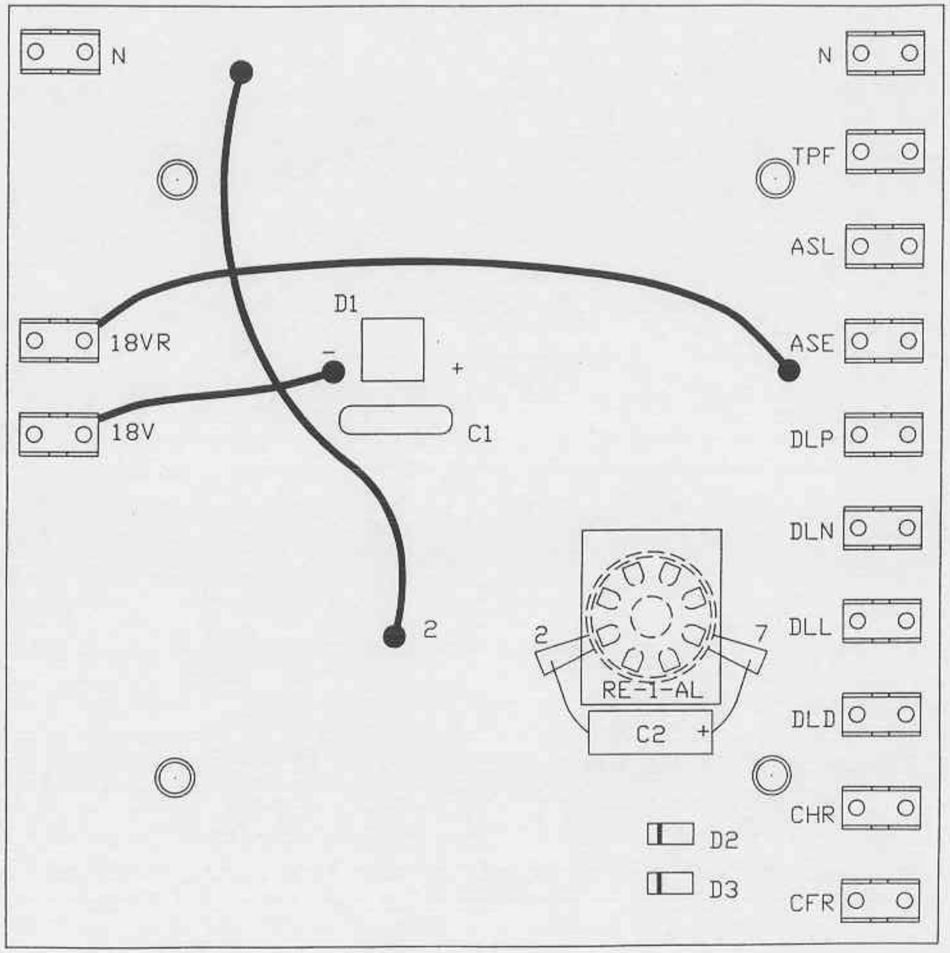
	Part Number	Description	Quantity		Reference Designators
27.	4182.234.02	22-18x6 Insulated Ring Terminal	4	EA	
28.	4182.234.03	16-14x6 Insulated Ring Terminal	2	EA	
29.	4182.234.04	22-18x8 Insulated Ring Terminal	7	EA	
30.	4182.234.05	16-14x8 Insulated Ring Terminal	9	EA	
31.	4182.234.06	22-18x10 Insulated Ring Terminal	1	EA	
32.	4182.234.07	16-14x10 Insulated Ring Terminal	2	EA	
33.	4182.234.08	22-18x6 Spade Tongue Insltd Termnl	4	EA	
34.	4186.062.01	36V 0CT 4 Amp Transformer	1	EA	
35.	4189.056.03	Thyrector Diode 125 Volt	2	EA	
36.	4246.062.01	Aux Box Cable Connector Plate	1	EA	
37.	4442.062.02	Table Tubestand Auxiliary Box Cover	1	EA	
38.	4542.062.01	Table Tubestand Auxiliary Box	1	EA	
39.	5184.062.01	Table Tbstnd Auxiliary Box Wire Set	1	EA	
40.	5287.062.01	Aux Box SFD Power Supply Cables	1	EA	
41.	5287.062.02	Aux Box Collimator Logic Cables	1	EA	
42.	6284.062.03	MXT 90/15 Mag Lock Power Supply PCB	1	EA	
43.	6284.062.05	MXT 90/15 Motor Carriage Drive Asm	1	EA	
44.	6284.062.06	MXT 90/15 Vari-Speed Tilt Cntrl PCB	1	EA	
45.	6284.062.07	MXT 90/15 Table Tilt Control PCB	1	EA	
46.	711.1457.0050	0.5 Amp Circuit Breaker	1	EA	
47.	711.1457.01	1.0 Amp Circuit Breaker	1	EA	
48.	711.1457.02	2.0 Amp Circuit Breaker	1	EA	
49.	711.1457.03	3.0 Amp Circuit Breaker	1	EA	
50.	711.1457.05	5.0 Amp Circuit Breaker	1	EA	
51.	711.1457.10	10.0 Amp Circuit Breaker	1	EA	
52.	713.5314.6031	Furnas 40 Amp 301C 115 Vac Relay	2	EA	

. . . continued on next page

TABLE 2-1 Parts List for 5785.062.01
Table Tubestand Auxiliary Box Asm

	Part Number	Description	Quantity		Reference Designators
53.	753.4101.25	5.00R 100W WW Adj Low T/C Resistor	1	EA	
54.	753.4101.35	50.00R 100W WW Adj Low T/C Resistor	2	EA	
55.	761.1562.10	4-Way Medium Duty Terminal Block	5	EA	
56.	761.1590.10	Medium Terminal Block End	1	EA	
57.	762.8521.0001	.250 #18 Female Cont Strip Tab Term	56	EA	
58.	762.8521.0002	.250 #14 Female Cont Strip Tab Term	4	EA	
59.	769.1405.7211	5 Pin Female Bulkhead Receptacle	1	EA	
60.	769.2837.4731	37 Pin Male Bulkhead Receptacle	1	EA	
61.	769.3166.1011	16-18 AWG Bulkhead Sockets	37	EA	
62.	769.3266.0991	16-18 AWG Bulkhead Pins	3	EA	
63.	769.3351.21	Shell Size 23 Large Strain Relief	1	EA	
64.	769.3394.55	Shell Size 14 Strain Relief	1	EA	
65.	771.5810.1420	1000 Mfd 200 Volt Elctyc Capacitor	1	EA	

TABLE 2-1 Parts List for 5785.062.01
Table Tubestand Auxiliary Box Asm

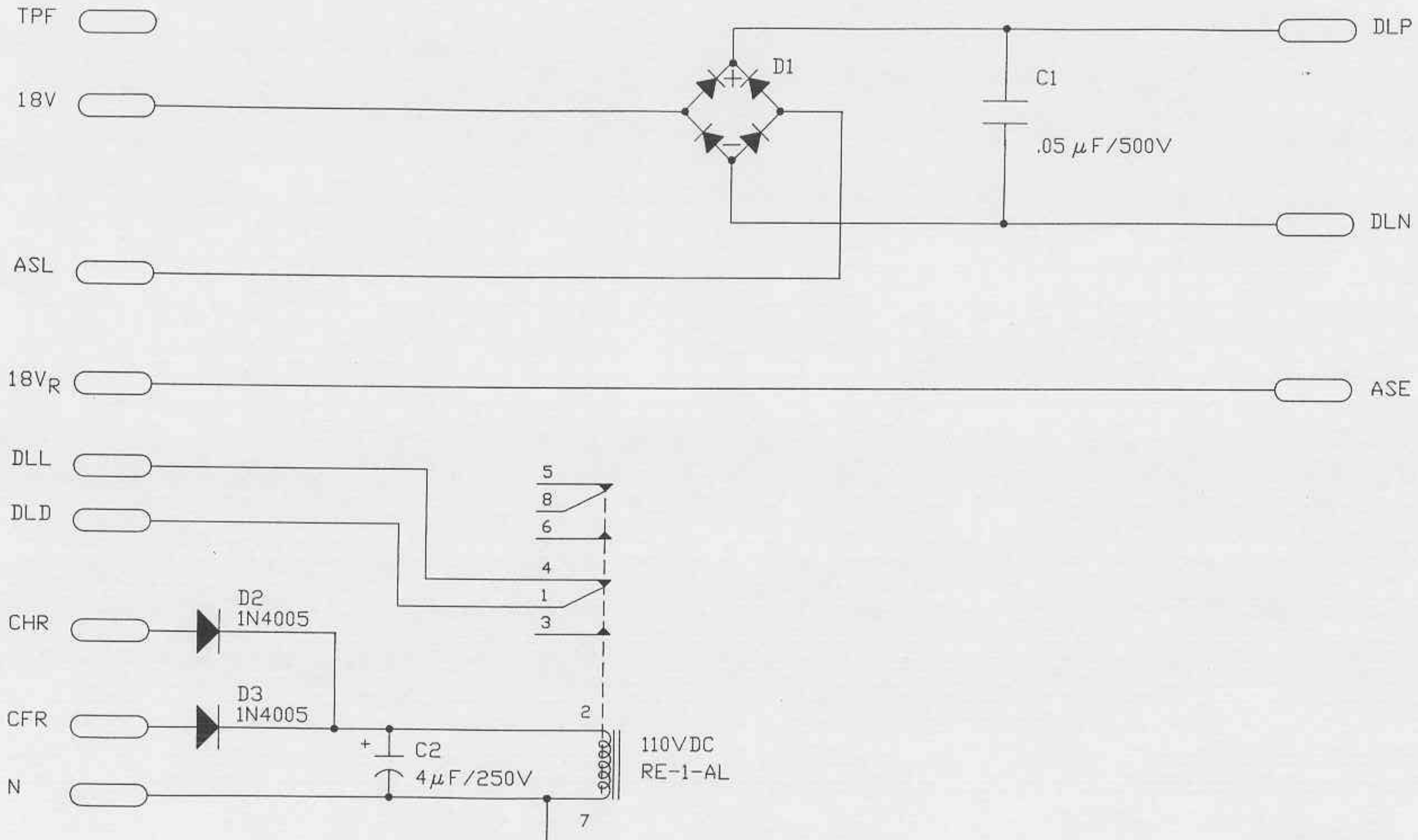

N
N
TPF
ASL
18VR
D1
ASE
18V
C1
DLP
DLN
2
2
7
DLL
RE-1-AL
DLD
C2
CHR
D2
D3
CFR

MXT 90/15 MAGNETIC LOCK POWER SUPPLY PCB

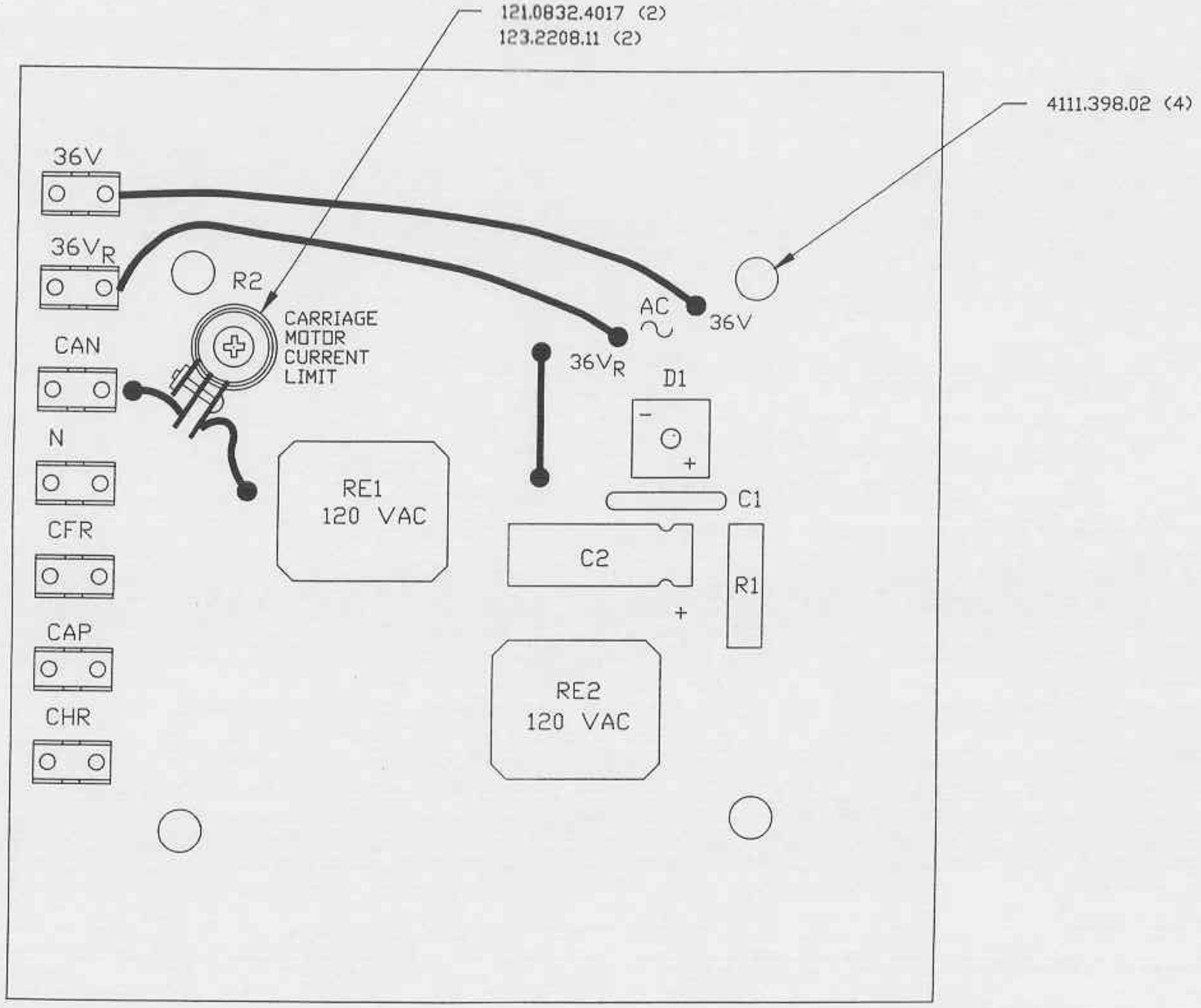
FIGURE 2-3 LAYOUT FOR 6284.062.03

	Part Number	Description	Quantity	Reference Designators
1.	129.5120.6511	1/8 X 3/16 Brass Eyelet	26 EA	
2.	135.3416.01	#16 Teflon Insulating Tubing	1.20 FT	
3.	135.5401.	GE SR900 Silicone Conformal Coating	.01 GL	
4.	4111.398.02	Etched Panel Mounting Bushing (3/4)	4 EA	
5.	4180.222.11	10K DPDT Octal Plug Relay	1 EA	RE-1-AL
6.	4182.132.12	4-Way Tab Terminal	13 EA	
7.	4182.222.04	8 Pin Octal Socket	1 EA	
8.	4284.062.03	MXT 90/15 Mag Lock Supply PC Blank	1 EA	
9.	738.0320.	20 Awg Solid Tinned Copper Wire	1.20 FT	
10.	771.1540.1425	4 Mfd 250 Volt Dc Elctyc Capacitor	1 EA	C2
11.	776.3350.1450	.05 Mfd 500 W Volt DC Disc Capacitr	1 EA	C1
12.	781.3605.6008	6A 600 PIV Silicon Bridge Rectifier	1 EA	D1
13.	782.1040.05	1N4005 1A 600V Silicon Rectifier	2 EA	D2,D3

TABLE 2-2 Parts List for 6284.062.03
MXT 90/15 Mag Lock Power Supply PCB


TPF
18V
ASL
$18V_R$
DLL
DLD
CHR
CFR
N
D1
C1
.05 µF/500V
DLP
DLN
ASE
N
5
8
6
4
1
3
2
7
D2
1N4005
D3
1N4005
C2
4µF/250V
110VDC
RE-1-AL

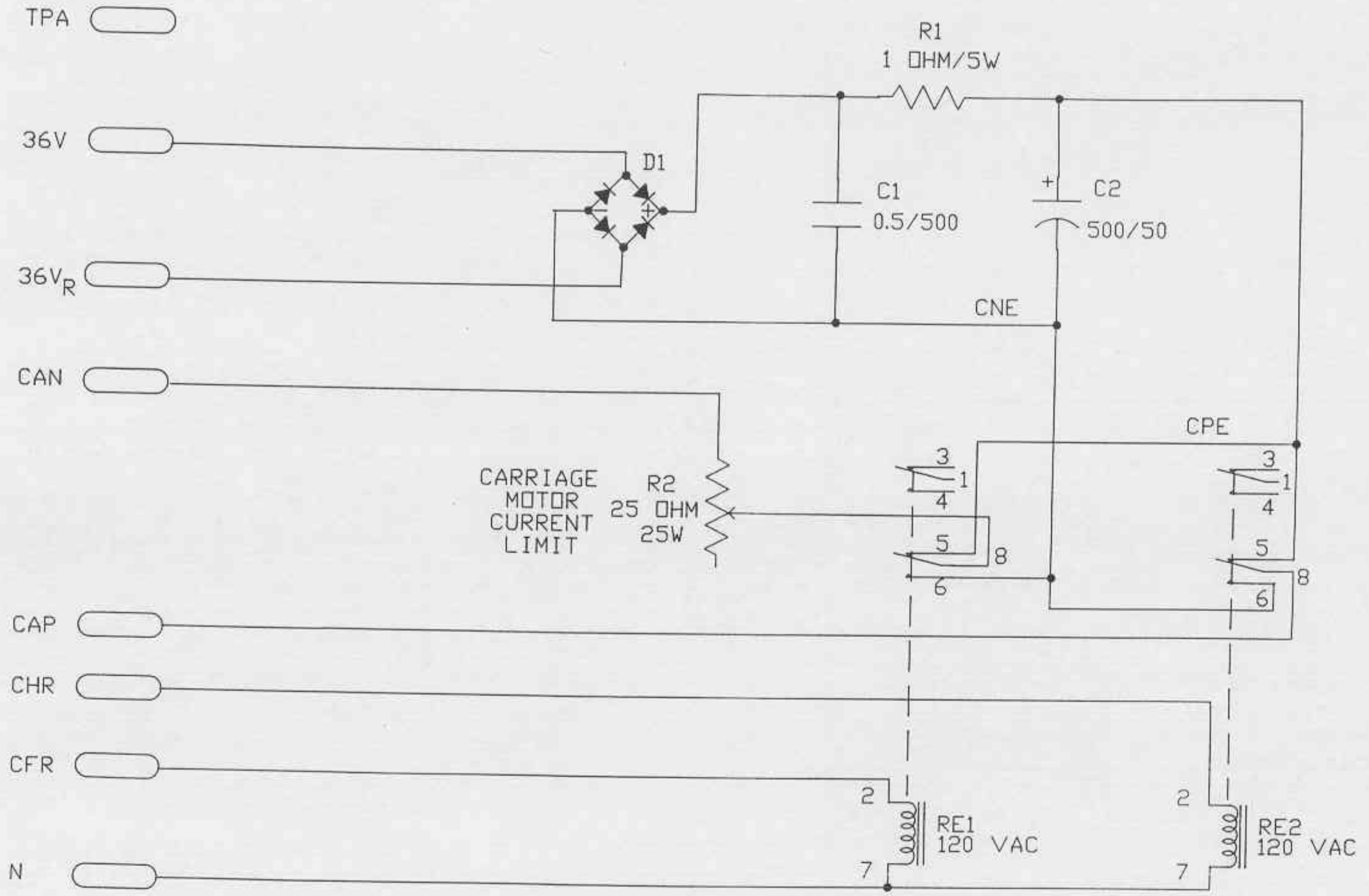
MXT 90/15 MAGNETIC LOCK POWER SUPPLY PCB
FIGURE 2-4 SCHEMATIC FOR 6284.062.03


121.0832.4017 (2)
123.2208.11 (2)
4111.398.02 (4)
36V
36VR
CAN
N
CFR
CAP
CHR
R2
CARRIAGE MOTOR CURRENT LIMIT
RE1 120 VAC
RE2 120 VAC
AC
36V
36VR
D1
C1
C2
R1
+

MXT 90/15 MOTOR CARRIAGE DRIVE PCB
FIGURE 2-5 LAYOUT FOR 6284.062.05

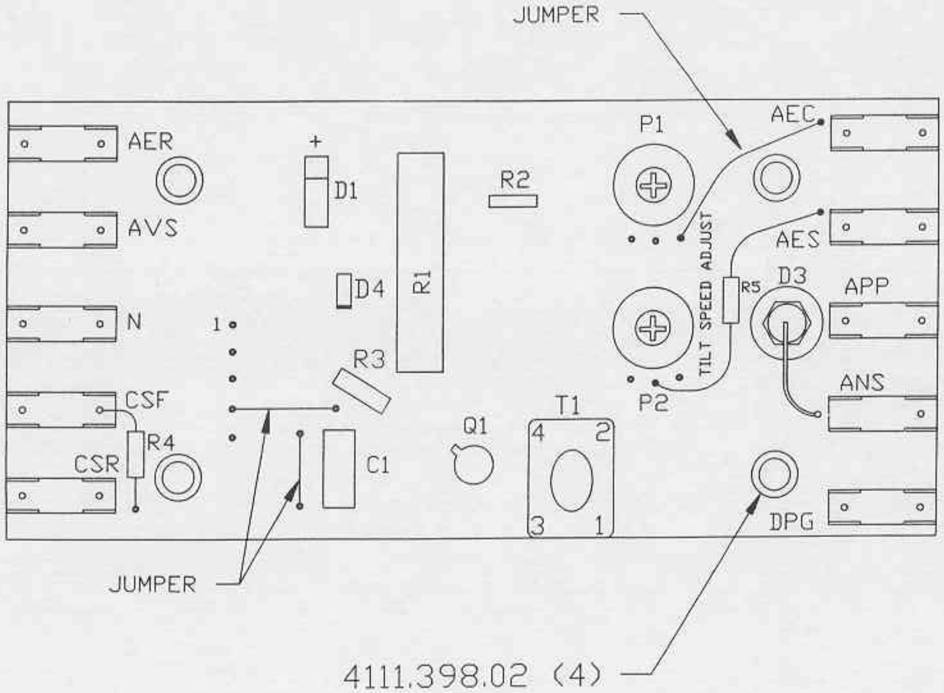
	Part Number	Description	Quantity	Reference Designators
1.	121.0832.4017	8-32 X 2-1/2 Round Steel Phlp Screw	1 EA	
2.	123.2208.11	.171 ID .500 OD .070Thk.Brass Wash.	1 EA	
3.	129.5120.6511	1/8 X 3/16 Brass Eyelet	14 EA	
4.	135.3416.01	#16 Teflon Insulating Tubing	1.40 FT	
5.	135.5401.	GE SR900 Silicone Conformal Coating	.01 GL	
6.	4111.398.02	Etched Panel Mounting Bushing (3/4)	4 EA	
7.	4118.122.05	8-32 X 112 Ch A Riv Nut	1 EA	
8.	4180.227.02	DPDT 115 Volt AC Plug Relay	2 EA	RE1,RE2
9.	4182.132.12	4-Way Tab Terminal	7 EA	
10.	4182.222.04	8 Pin Octal Socket	2 EA	
11.	4284.062.05	MXT 90/15 Carriage Drive PC Blank	1 EA	
12.	738.0320.	20 Awg Solid Tinned Copper Wire	1.50 FT	
13.	752.2506.21	1R 5W 5% Fixed WW Low T/C Resistor	1 EA	R1
14.	753.3251.3250	25.00R 25W WW Adj Low T/C Resistor	1 EA	R2
15.	771.1750.1350	500 Mfd 50 Volt Elctyc Capacitor	1 EA	C2
16.	776.3350.1450	.05 Mfd 500 W Volt DC Disc Capacitr	1 EA	C1
17.	781.3605.6008	6A 600 PIV Silicon Bridge Rectifier	1 EA	D1

TABLE 2-3 Parts List for 6284.062.05
MXT 90/15 Motor Carriage Drive Asm


TPA
36V
36VR
CAN
CAP
CHR
CFR
N
R1
1 OHM/5W
D1
C1
0.5/500
C2
500/50
CNE
CPE
CARRIAGE
MOTOR
CURRENT
LIMIT
R2
25 OHM
25W
3
1
4
5
8
6
3
1
4
5
8
6
2
RE1
120 VAC
7
2
RE2
120 VAC
7

MXT 90/15 MOTOR CARRIAGE DRIVE PCB

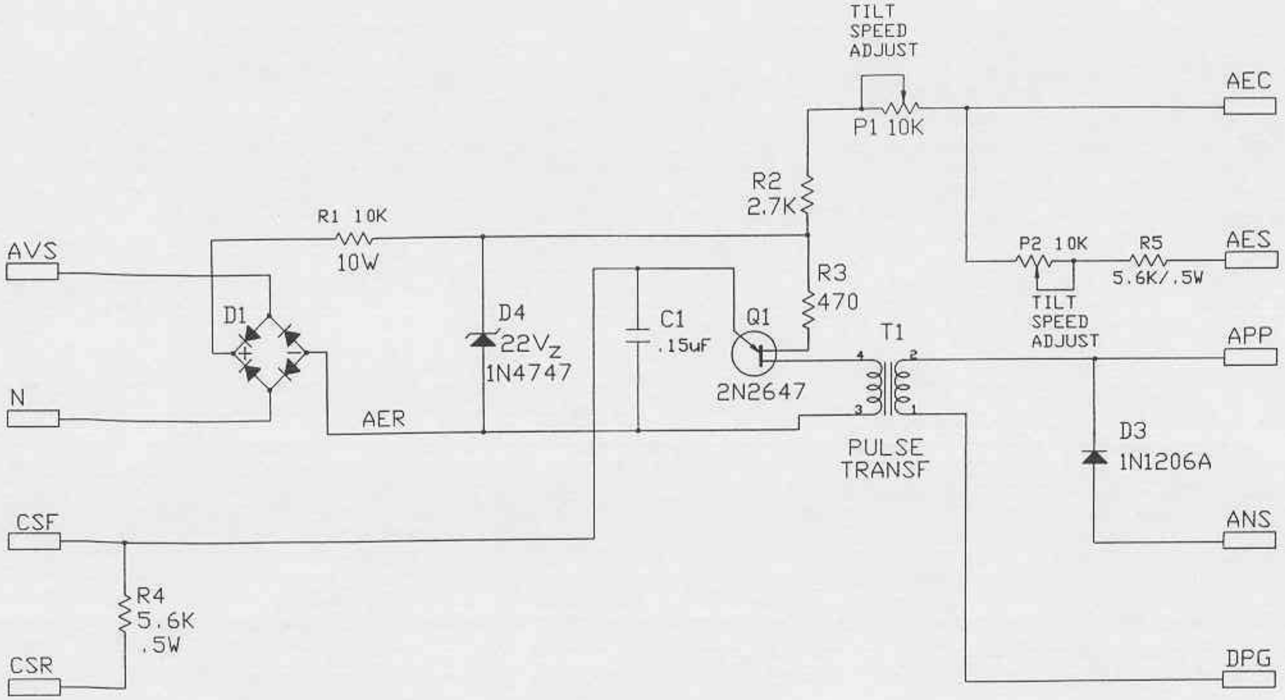
FIGURE 2-6 SCHEMATIC FOR 6284.062.05


JUMPER
AER
AVS
N
CSF
R4
CSR
+
D1
D4
R1
1
R3
C1
Q1
R2
T1
4
2
3
1
P1
P2
TILT SPEED ADJUST
R5
AEC
AES
D3
APP
ANS
DPG
JUMPER
4111.398.02 (4)

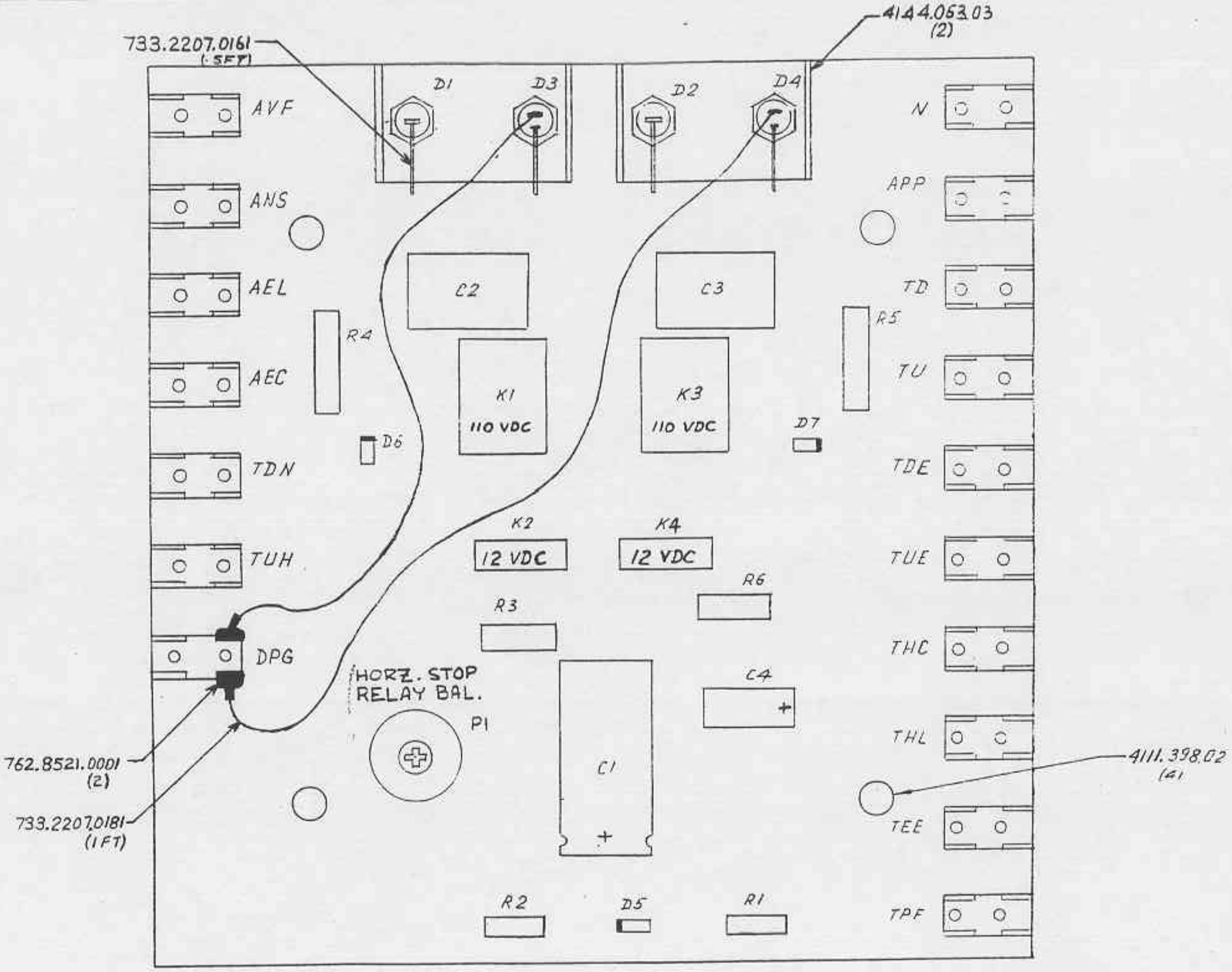
MXT 90/15 VARI-SPEED TILT CONTROL PCB
FIGURE 2-7 LAYOUT FOR 6284.062.06

	Part Number	Description	Quantity	Reference Designators
1.	129.5120.6511	1/8 X 3/16 Brass Eyelet	20 EA	
2.	135.3416.01	#16 Teflon Insulating Tubing	.50 FT	
3.	135.5401.	GE SR900 Silicone Conformal Coating	.01 GL	
4.	4111.398.02	Etched Panel Mounting Bushing (3/4)	4 EA	
5.	4182.132.12	4-Way Tab Terminal	10 EA	
6.	4186.056.02	PCP Pulse Transformer	1 EA	T1
7.	4284.062.06	MXT 90/15 Vari-Speed Tilt PC Blnk	1 EA	
8.	738.0320.	20 Awg Solid Tinned Copper Wire	.40 FT	
9.	751.1506.4470	470R 1/2 Watt 5% Carbon Resistor	1 EA	R3
10.	751.1506.5270	2.7K 1/2 Watt 5% Carbon Resistor	1 EA	R2
11.	751.1506.5560	5.6K 1/2 Watt 5% Carbon Resistor	2 EA	R4,R5
12.	752.3106.61	10K 10Watt 5% FxdWW Low T/C Resistr	1 EA	R1
13.	755.2206.1001	10K 2 Watt WW Low T/C Potentiometer	2 EA	P1,P2
14.	772.2415.4425	.15 Mfd 250 Vdc 5% Mylar Capacitor	1 EA	C1
15.	781.3205.6006	600 PIV 2.0 Amp FW Bridge Rectifier	1 EA	D1
16.	782.1012.0628	1N1206A 12 Amp 600 Piv Rectifier	1 EA	D3
17.	782.1047.47	1N4747 20 Volt Zener Diode	1 EA	D4
18.	782.2026.47	GE-2N2647 UJ Transistor	1 EA	Q1

TABLE 2-4 Parts List for 6284.062.06
MXT 90/15 Vari-Speed Tilt Cntrl PCB


TILT
SPEED
ADJUST
P1 10K
AEC
R2
2.7K
R1 10K
10W
AVS
P2 10K
R5
5.6K/.5W
AES
TILT
SPEED
ADJUST
R3
470
D1
D4
22V$_Z$
1N4747
C1
.15uF
Q1
2N2647
T1
APP
N
AER
PULSE
TRANSF
D3
1N1206A
CSF
ANS
R4
5.6K
.5W
CSR
DPG

MXT 90/15 VARI-SPEED TILT CONTROL PCB
FIGURE 2-8 SCHEMATIC FOR 6284.062.06

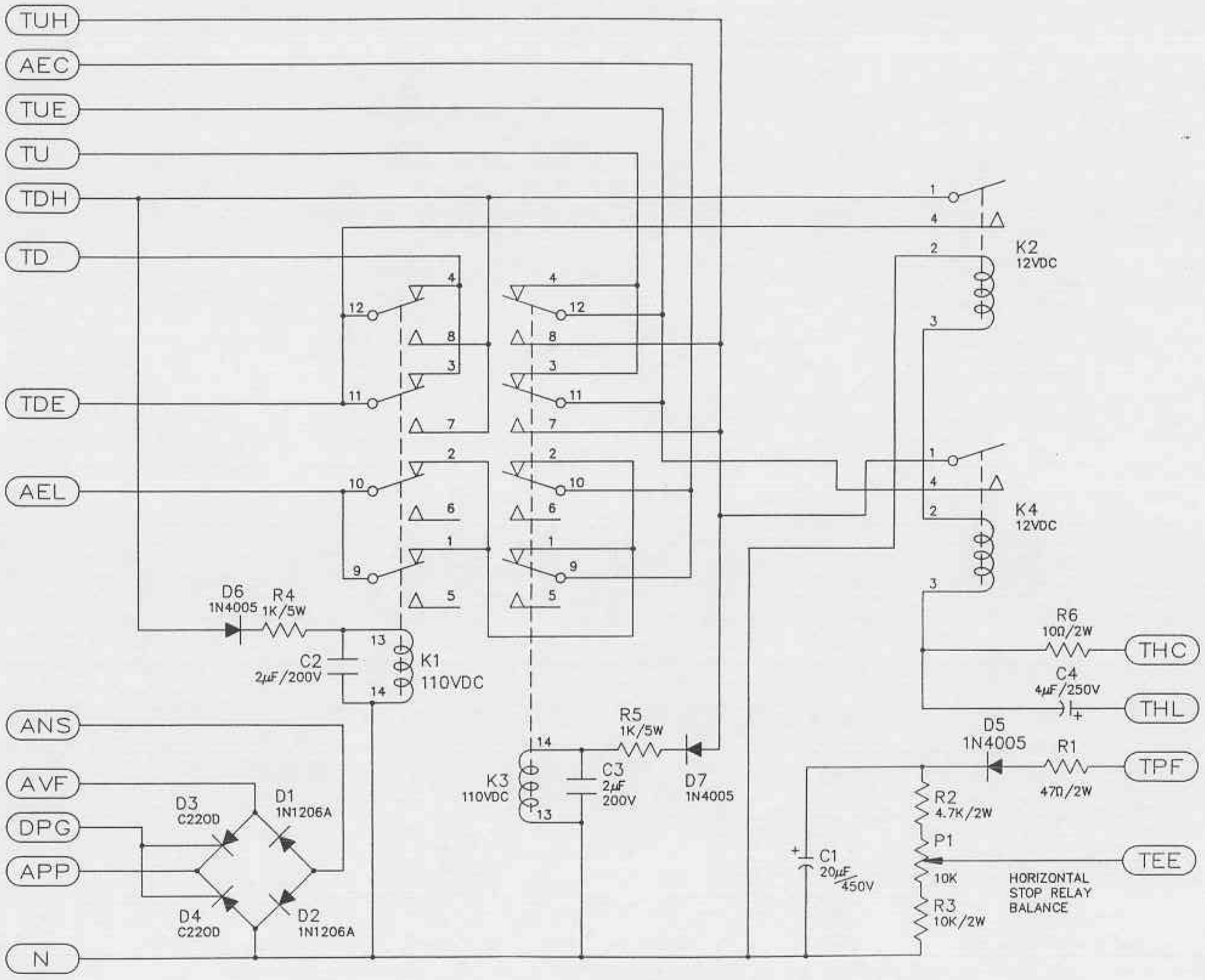

733.2207.0161
(.5FT)
4144.063.03
(2)
D1
D3
D2
D4
AVF
ANS
AEL
AEC
TDN
TUH
DPG
N
APP
TD
TU
TDE
TUE
THC
THL
TEE
TPF
C2
C3
R4
R5
K1
110 VDC
K3
110 VDC
D6
D7
K2
12 VDC
K4
12 VDC
R6
R3
C4
HORZ. STOP
RELAY BAL.
P1
C1
4111.398.02
(4)
762.8521.0001
(2)
733.2207.0181
(1FT)
R2
D5
R1

MXT 90/15 TABLE TILT CONTROL PCB
FIGURE 2-9 LAYOUT FOR 6284.062.07

DIETZGEN NO. 190M ACEPROOF NO. 316.12

	Part Number	Description	Quantity	Reference Designators
1.	129.5120.6511	1/8 X 3/16 Brass Eyelet	34 EA	
2.	135.3300.8002	1/8" Black I/P Heat Shrink Tubing	.20 FT	
3.	135.5401.	GE SR900 Silicone Conformal Coating	.01 GL	
4.	4111.398.02	Etched Panel Mounting Bushing (3/4)	4 EA	
5.	4144.063.03	2-1/8 X 1 X 1 T066 Heat Sink	2 EA	
6.	4180.391.07	12 Volt DC Reed Relay SPST	2 EA	K2,K4
7.	4182.132.12	4-Way Tab Terminal	17 EA	
8.	4284.062.07	MXT 90/15 Table Tilt Cntrl PC Blank	1 EA	
9.	714.4687.1222	4PDT 110 Volt DC Mini Power Relay	2 EA	K1,K3
10.	714.9001.	4PDT Mini Relay Pc Socket	2 EA	
11.	714.9002.	Relay Hold-Down Spring	2 EA	
12.	733.2207.0161	22 Ga 1 Con 300v Blue Hookup Wire	.50 FT	
13.	733.2207.0181	22 Ga 1 Con 300v Gray Hookup Wire	1 FT	
14.	751.2106.5470	4.7K 1 Watt 5% Carbon Resistor	1 EA	R2
15.	751.2206.31	10 R 2 Watt 5% Carbon Resistor	1 EA	R6
16.	751.2206.3470	47 R 2 Watt 5% Carbon Resistor	1 EA	R1
17.	751.2206.61	10K 2 Watt 5% Carbon Resistor	1 EA	R3
18.	752.2506.51	1K 5W 5% Fixed WW Low T/C Resistor	2 EA	R4,R5
19.	755.2206.1001	10K 2 Watt WW Low T/C Potentiometer	1 EA	P1
20.	762.8521.0001	.250 #18 Female Cont Strip Tab Term	2 EA	
21.	771.1540.1425	4 Mfd 250 Volt Dc Elctyc Capacitor	1 EA	C4
22.	771.1620.1445	20 Mfd 450 Volt Elctyc Capacitor	1 EA	C1
23.	773.1520.0420	2 Mfd 200 Volt #1 Mylar Capacitor	2 EA	C2,C3
24.	782.1012.0628	1N1206A 12 Amp 600 Piv Rectifier	2 EA	D1,D2
25.	782.1040.05	1N4005 1A 600V Silicon Rectifier	3 EA	D5-D7
26.	784.3745.4020	C220D Silicon Controlled Rectifier	2 EA	D3,D4

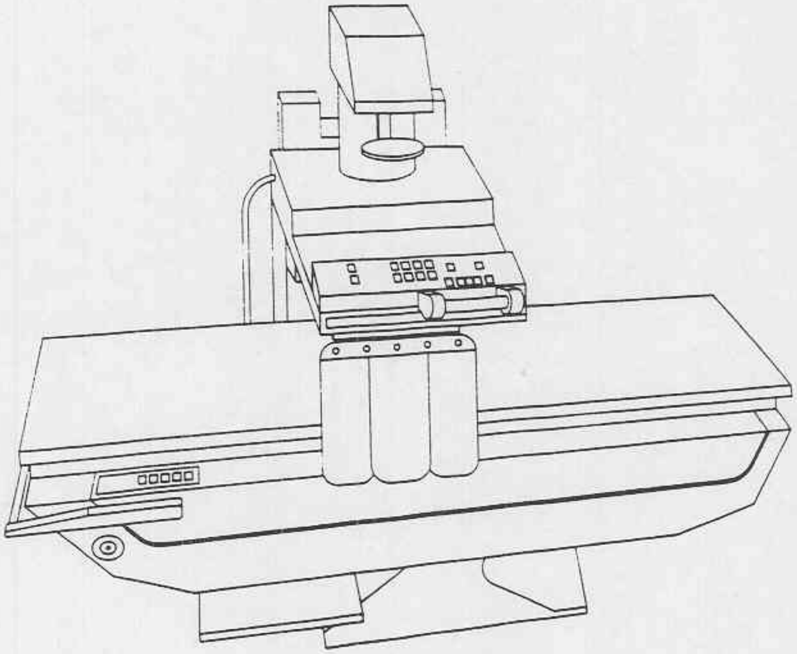
TABLE 2-5 Parts List for 6284.062.07
MXT 90/15 Table Tilt Control PCB


TUH
AEC
TUE
TU
TDH
TD
TDE
AEL
ANS
AVF
DPG
APP
N
K2
12VDC
K4
12VDC
D6
1N4005
R4
1K/5W
C2
2µF/200V
K1
110VDC
K3
110VDC
R5
1K/5W
D7
1N4005
C3
2µF
200V
D3
C220D
D1
1N1206A
D4
C220D
D2
1N1206A
R6
10Ω/2W
THC
C4
4µF/250V
THL
D5
1N4005
R1
47Ω/2W
TPF
R2
4.7K/2W
P1
10K
R3
10K/2W
C1
20µF
450V
TEE
HORIZONTAL
STOP RELAY
BALANCE

MXT 90/15 TABLE TILT CONTROL PCB
FIGURE 2-10 SCHEMATIC FOR 6284.062.07

CHAPTER 10

SPOT FILM DEVICE



EUREKA

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Arlington Heights, IL 60067

(708) 394-5800
(800) 545-3126
FAX (708) 394-5903
TWX (910) 221-5632

EXT-950 (DPSC)

Spotfilm Device

Installation
Operation
and Maintenance

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00-02-1360

TABLE OF CONTENTS

SECTION PAGE

1.0 INTRODUCTION

1.1 Features 1-2
1.1.1 Simplicity 1-2
1.1.2 Standard Features 1-2
1.1.3 Advanced Features 1-2
1.2 SPECIFICATIONS 1-3

2.0 INSTALLATION

2.1 Unpacking 2-2
2.2 Storage 2-2
2.3 Equipment Supplied 2-3
2.4 Mounting Accessory Devices 2-3
2.5 Interconnecting Wiring 2-3
2.6 X-ray Generator Wiring 2-4

3.0 OPERATIONAL CHECKOUT PROCEDURE

3.1 Operational Checklist 3-2
3.2 Power Assist Checkout 3-3

4.0 CALIBRATION

5.0 OPERATION

5.1 Radiation Protection 5-2
5.2 Maximum Permissible Dose 5-3
5.3 Manufacturer's Responsibility 5-3
5.4 Monitoring of Personnel 5-5
5.5 Pushbutton Switches and LED Display 5-5
5.6 Power Assist Handle 5-9
5.7 Manual Positioning 5-10
5.8 Operating Procedures 5-10
5.9 Operating Details 5-12
5.10 Operator Maintenance 5-13
5.11 Operational Tests 5-14
5.12 Cleaning 5-14

SECTION **PAGE**

6.0 COMPLIANCE VERIFICATION

6.1 Verification Test to be Performed 6-3
XR8-2.16 Minimum Field Size 6-4
XR8-2.20 X-Ray Field Limitation and Alignment 6-6
XR8-2.24 Fluoroscopic X-Ray Field Limitation 6-9
XR8-2.29 Alignment of X-Ray Field Edges to Selected Portions of the Image Receptor 6-15
XR8-2.30 Alignment of Center of X-Ray Field to Center of Selected Portion of Image Receptor 6-19

7.0 MAINTENANCE/REPAIR

7.1 Corrective Maintenance 7-2
7.2 Rear Cover Removal and Replacement 7-2
7.3 Front Cover Removal 7-3
7.4 Position Sensing 7-4
7.5 Adjustment of Chassis Sensors 7-4
7.6 Establishing Home Position of Cassette Carriage 7-7
7.7 Adjustment of Handle Sensors 7-8
7.8 Interface Circuit Board Removal and Replacement 7-9
7.9 CPU Circuit Board Removal and Replacement 7-9
7.10 Front Panel Circuit Board Removal and Replacement 7-10
7.11 Stepper Motor Replacement 7-11
7.12 Clutch/Brake Assembly Replacement 7-12
7.13 Belt Replacement 7-13
7.13.1 Front-to-Back Belt Replacement 7-14
7.13.2 Side-to-Side Belt Replacement 7-15

8.0 THEORY OF OPERATION

8.1 Mechanical Operation 8-2
8.2 Introduction to Electronic Theory 8-2
8.3 Block Diagram Discussion 8-3
8.4 Circuit Description 8-3
8.4.1 CPU Board (70-08078) 8-5
8.4.2 Interface Board (70-08077) 8-7
8.4.3 Keyboard/Display Board (70-08079) 8-9
8.4.4 Power Supply (70-10416) 8-10

9.0 NOT APPLICABLE FOR THIS MANUAL

10.0 SCHEMATICS AND BILLS OF MATERIAL

APPENDIX I

Mounting to Xonics Aries Table

TABLE OF CONTENTS

Tables, Charts, Figures and Illustrations

SECTION	FIGURE		PAGE
1.0	1.1	Outline Data	1-4
2.0	2.1	J7 Wiring	2-3
	2.2	J8 Wiring	2-3
	2.3	J9 Wiring	2-4
5.0	5.1	Front Panel Controls and Indicators	5-4
	5.2	Format/Status Displays	5-7
	5.3	Power Assist Handle Operation	5-9
6.0	6.1	CDRH/FDA Compliance Test Stand	6-2
	6.2	Compliance Test Stand Detail	6-2
	6.3	Fluoroscopic X-ray Field Limitation, Test Stand Method	6-10
	6.4	Fluoroscopic X-ray Field Limitation, Direct Method	6-13
	6.5	Image Intensified Fluoroscope, Metal Marker Method, Outside Edge	6-13
	6.6	Undertable Tube, Test Set-Up	6-14
	6.7	Determination of SID	6-17
	6.8	Spotfilm X-ray Field Limitation, Test Stand Method, Reference	6-18
	6.9	Spotfilm X-ray Field Limitation, Test Stand Method, Actual	6-18

SECTION	FIGURE		PAGE
7.0	7.1	Rear Cover Removal	7-2
	7.2	Front Cover Removal	7-3
	7.3	I.I. Adapter Plate Removal	7-3
	7.4	Chassis Sensor Locations	7-4
	7.5	Cassette Present Sensor Detail	7-6
	7.6	Load Position Sensor Detail	7-6
	7.7	Park Position Sensors Detail	7-6
	7.8	Power Supply Front Panel (F4)	7-7
	7.9	Side Movement Handle Sensor Detail	7-8
	7.10	Power Assist Handle Adjustment	7-8
	7.11	Interface Circuit Board Removal	7-9
	7.12	CPU Circuit Board Removal	7-9
	7.13	Front Panel Circuit Board Removal	7-10
	7.14	Driveshaft Decoupling	7-10
	7.15	Side-to-Side Belt Tensioning Adjustment	7-11
	7.16	Motor Replacement	7-11
	7.17	J6 Wiring	7-12
	7.18	AC Input Terminal Block Detail	7-12
	7.19	Clutch/Brake Replacement	7-13
	7.20	Front-to-Back Belt Tensioning Adjustment	7-13
	7.21	Cassette Carriage to Belt Disassembly	7-14
	7.22	Side-to-Side Front Idler Pulley Detail	7-14
	7.23	Leadscrew Pulley Setscrew Detail	7-15
	7.24	Leadscrew Mounting Bracket Removal	7-15
8.0	8.1	System Block Diagram	8-4
	8.2	Simplified Schematic - Keyboard Interface	8-8
10.0	10.1	Power Supply Schematic 70-10416	10-5
	10.2	Z80 Interface BD Analog Schematic 70-08077	10-8
	10.3	Z80 Interface BD Digital Schematic 70-08077	10-9
	10.4	Z80 Interface BD Terminal Design 70-08077	10-10
	10.5	Z80 Interface BD Assembly 70-08077	10-11
	10.6	Z80 CPU Board Digital Schematic 70-08078	10-14
	10.7	Z80 CPU Board I/O Schematic 70-08078	10-15
	10.8	Z80 CPU Board Assembly 70-08078	10-16
	10.9	Keyboard/Display Schematic 70-08079	10-19
	10.10	Keyboard/Display Assembly 70-08079	10-20

SECTION	TABLE		PAGE
7.0	7.1	Symptoms, Causes and Cures for Chassis Sensors	7-5
10.0	10.1	Bill of Materials EXT-950 POWER SUPPLY 70-10416	10-3
	10.2	Bill of Materials EXT Z80 INTERFACE PCB Assembly 70-08077	10-6
	10.3	Bill of Materials EXT Z80 INTERFACE BOARD ASSEMBLY 70-08078	10-12
	10.4	Bill of Materials EXT Z80 INTERFACE PCB ASSEMBLY 70-08079	10-17

NO TEXT

SECTION 1.0

INTRODUCTION

1.0 INTRODUCTION

This technical manual contains information on the installation, adjustment, operation, maintenance and repair of the EXT-950 (DPSC) Spotfilm Device (SFD) manufactured by EUREKA X-RAY TUBE, INC.

1.1 FEATURES

1.1.1 SIMPLICITY

From the single-motor mechanical design to the extensive use of microprocessor technology, simplicity of operation - with increased reliability as a result - was paramount in the development of this device.

The microprocessor-based design allows a single motor, with a direct output to a state-of-the-art composite toothed belt, to control side-to-side carriage movement and another output, routed through a clutch/brake, to control longitudinal movement. This patented design cuts down considerably on both electronic and mechanical complexity.

All circuitry is modular, with plug-in headers and easily removable circuit boards.

1.1.2 STANDARD FEATURES

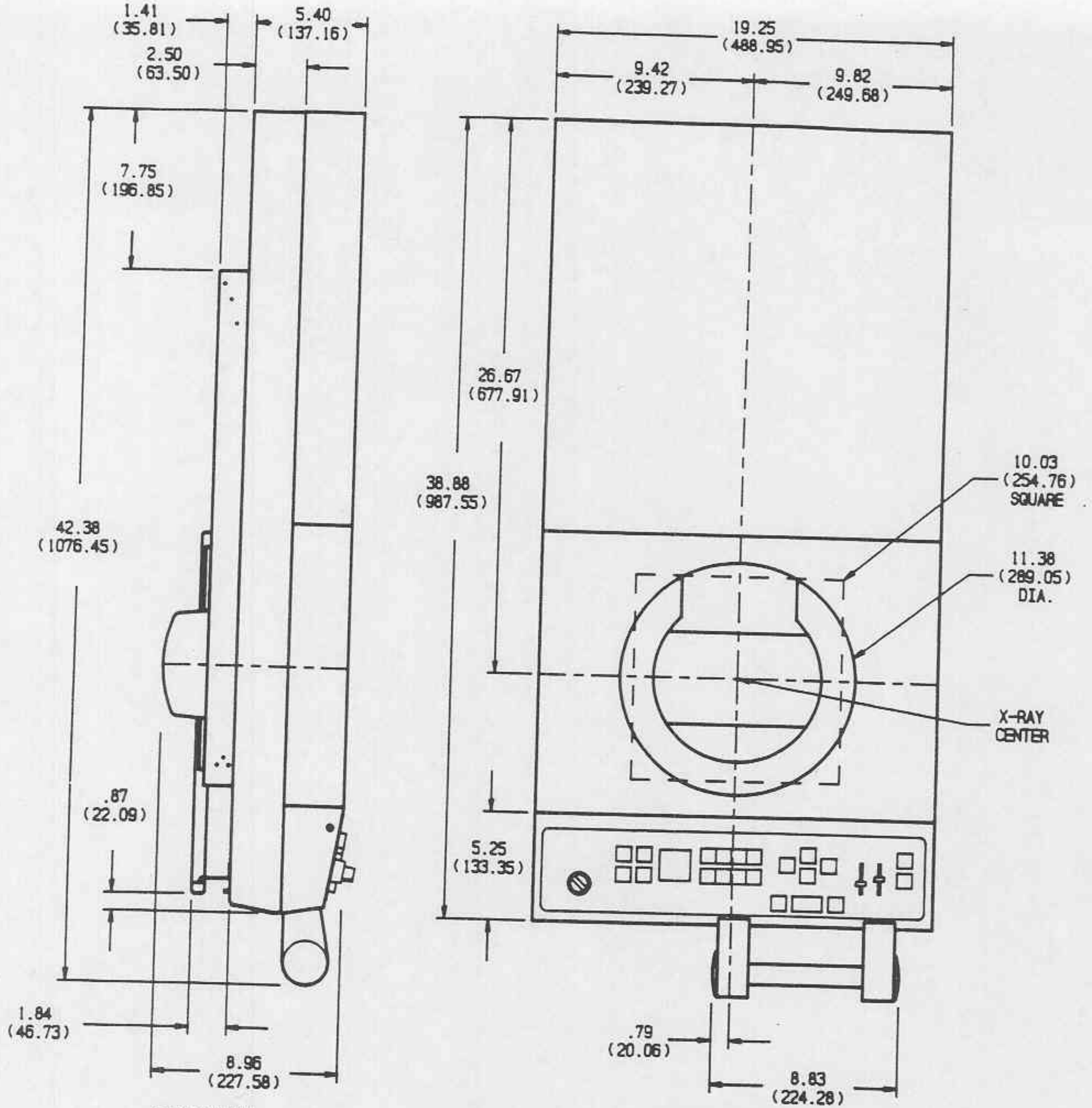
... lightweight and compact (less than 98 lbs.)
... fast response; as many as 3 exposures per second (on a 3-on-1 format).
... 2-way tabletop controls.
... feather-touch vertical and longitudinal power assist.
... carriage and compression locks.
... table tilt control.
... collimator shutter controls and auto/manual collimation selection.

1.1.3 ADVANCED FEATURES

... front panel LED status display for format, cassette jams and open interlock conditions.
... microprocessor controls all functions for reliability and simplicity.
... foolproof cassette insertion.
... electromagnetic clutch/brake allows rapid indexing.

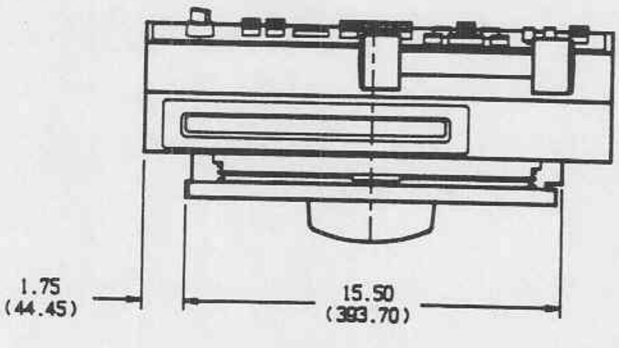
1.2 SPECIFICATIONS

Spotfilm Formats:		1-, 2-, 3-, 4-, 6- and 9-on-1
Cassette Size:		9.5" x 9.5" (24 cm x 24 cm)
Format Sizes:	1-on-1	9.25" x 9.25" (23.5 cm x 23.5 cm)
	2-on-1	9.25" x 4.5" (23.5 cm x 11.4 cm)
	3-on-1	9.25" x 3.0" (23.5 cm x 7.6 cm)
	4-on-1	4.5" x 4.5" (11.4 cm x 11.4 cm)
	6-on-1	4.5" x 3.0" (11.4 cm x 7.6 cm)
	9-on-1	2.5" x 2.5" (6.3 cm x 6.3 cm)
Exposure Initiation:		750 ms (from cassette insertion)
Auto. Exposure Sequencing:		500 ms (3 exposures/second for 3-on-1, all others, 2 exposures/second)
Power Requirements:		24 VAC, 50/60 Hz, W
Relay Contacts:		Form "C"
Dimensions:		See OUTLINE DATA


1.41
(35.81)
5.40
(137.16)
2.50
(63.50)
7.75
(196.85)
42.38
(1076.45)
.87
(22.09)
1.84
(46.73)
8.96
(227.58)
19.25
(488.95)
9.42
(239.27)
9.82
(249.68)
26.67
(677.91)
38.88
(987.55)
5.25
(133.35)
10.03
(254.76)
SQUARE
11.38
(289.05)
DIA.
X-RAY
CENTER
.79
(20.06)
8.83
(224.28)

SIDE VIEW

TOP VIEW


1.75
(44.45)
15.50
(393.70)

INCHES
(MILLIMETERS)

FRONT VIEW

OUTLINE DATA

Figure 1.1

SECTION 2.0

INSTALLATION

2.0 INSTALLATION

2.1 UNPACKING

Before beginning to unpack the SFD, move it as close as practical to the installation site to minimize relocation after unpacking. Exercise caution during unpacking and installation to prevent damage to both the SFD and the packing material. It is recommended that packing material be retained for possible future re-use.

Lift the SFD from the packing crate.

CAUTION: *Do NOT place the SFD on a flat surface without protecting the compression cone at this, or any other time, during installation.*

Do not use the Power Assist handle (at the front of the SFD) to lift the SFD at any time during installation. This handle is NOT designed to support the weight of the unit.

Inspect the contents of the shipping container as it is unpacked. While inspecting the SFD, keep in mind that it is relatively fragile and can be damaged by rough handling. If the unit shows any sign of damage, immediately discontinue packing and notify the carrier.

Covers and Hardware
Inspect the covers for dents, scratches, or other damage that may have occurred during shipping. Examine the bags containing the hardware. If any of these bags are torn or otherwise damaged, hardware may be lost or loose in the shipping container.

2.2 STORAGE

The SFD can be stored for as long as eight years in environments whose temperature and relative humidity do not exceed 85° F (30° C) and 70%. Exceeding these limits may cause deterioration of the cassette carriage drive belts.

In addition, tension on the drive belts may distort them when they are unused for an extended period of time. Therefore, it is recommended that the tension be relaxed on all belts if the SFD is to be stored for more than six months. Do this by loosening both tensioning idler pulleys inside the SFD. Refer to Section 7.13.

Prepare the SFD for storage by repacking it in its original shipping material whenever possible. If the original packing material is not available, use a heavy-duty corrugated cardboard carton or, preferably, a wooden crate whose inside dimensions exceed those of the SFD by at least 15% in all directions.

Before placing the SFD in the container, cushion the bottom with no less than 2 inches (50 mm) of foam padding or other similar material. After centering the unit in the container, fill all empty spaces, including the top, with enough padding to prevent shifting. Finally, use a high quality tape to seal the container or nail it shut, as appropriate. Masking tape is NOT recommended with cardboard cartons because its adhesive often fails as it ages.

Avoid stacking heavy items on top of the container during storage and make sure that the equipment is protected against damage.

2.3 EQUIPMENT SUPPLIED

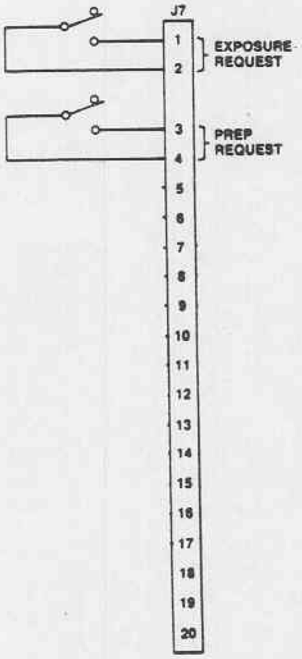
...EXT-950 (DPSC) Spotfilm Device
...24 VAC Power Supply (Optional)
...Installation, Operation and Maintenance Manual

2.4 MOUNTING ACCESSORY DEVICES

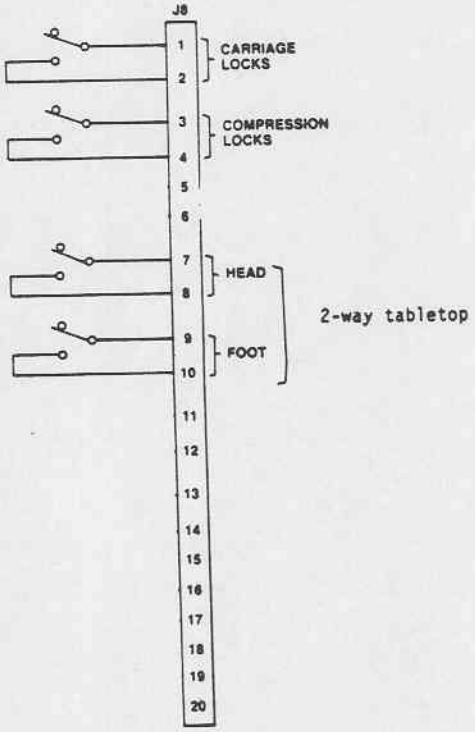
Mounting rails (with multiple slots) are attached to the underside of the SFD. Designed for devices having mounting surfaces separated by 13", (with the exception of the uppermost slot, which is 13 1/2") these rails can accommodate an ionization chamber, a grid, a 2-on-1 mask and a compression cone simultaneously. The devices should be slid into the tracks in the order mentioned; i.e., ionization chamber in the uppermost (widest) slot and compression cone in the lowest. (The 2-on-1 mask should be omitted for other formats.)

2.5 INTERCONNECTING WIRING

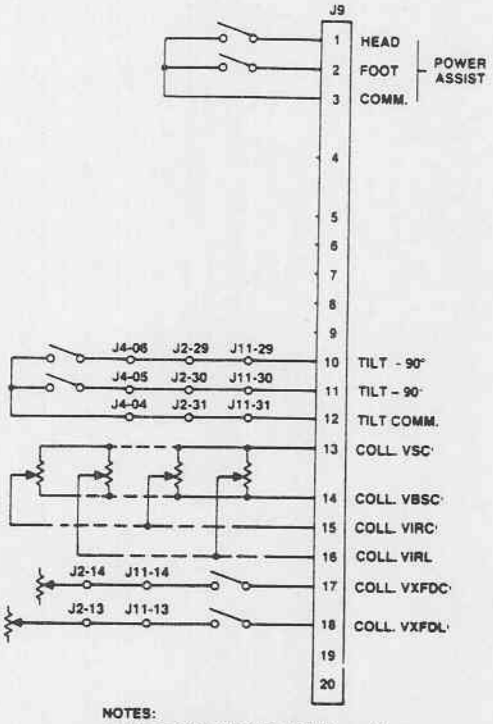
All external connections are made through three headers on the Interface (upper) Board: J7, J8 and J9. These connection points are shown in figures 2.1, 2.2 and 2.3, respectively. The X-ray generator and image intensifier wiring is connected to J7; locks and tabletop motion controls to J8; and power assist/collimator wiring to J9. Standard wiring practices in accordance with the National Electrical Code and any local codes should be followed. All cables carrying low voltage DC should be separated as far as possible from any that carry AC, especially line voltage. Not only does this minimize EMI (ElectroMagnetic Interference), but also provides a margin of safety when servicing is performed.


J7
1
2
EXPOSURE REQUEST
3
4
PREP REQUEST
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

J7 WIRING
Figure 2.1


J8
1
2
CARRIAGE LOCKS
3
4
COMPRESSION LOCKS
5
6
7
8
HEAD
9
10
FOOT
2-way tabletop
11
12
13
14
15
16
17
18
19
20

J8 WIRING
Figure 2.2


J9
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
HEAD
FOOT
COMM.
POWER ASSIST
J4-06
J2-29
J11-29
J4-05
J2-30
J11-30
J4-04
J2-31
J11-31
TILT - 90°
TILT – 90°
TILT COMM.
COLL. VSC'
COLL. VBSC'
COLL. VIRC'
COLL. VIRL
J2-14
J11-14
COLL. VXFDC'
J2-13
J11-13
COLL. VXFDL'

NOTES:

1. Refer to GLOSSARY for definitions of terms.
2. "J11" designations are for Interface Board ribbon cable, "J2" designations are for Front Panel Board ribbon cable, "J4" designations are for Front Panel Board header.

J9 WIRING

Figure 2.3

2.6 X-RAY GENERATOR WIRING

The X-ray generator must be wired to the Exposure Request and Prep Request terminals (J7-1, -2 and J7-3, -4). The relay contacts available are normally open and rated for 1 Amp. at 24 VDC, 0.5 Amp. at 120 VAC.

SECTION 3.0

OPERATIONAL CHECKOUT PROCEDURE

3.0 OPERATIONAL CHECKOUT PROCEDURE

3.1 OPERATIONAL CHECKLIST

NOTE: The procedure in this paragraph assumes that the entire radiographic//fluorographic system is fully installed and ready for calibration. Therefore, make sure that the SFD is completely installed before performing the procedure in this paragraph.

This procedure tests only SFD operation. It does NOT test the generator and other system components that are not under the direct control of the SFD.

Refer to Section 5, as needed, while performing the procedure in this paragraph.

1. Apply power to the system.

☢ **WARNING** ☢

THE FOLLOWING PROCEDURES INVOLVE THE PRODUCTION OF X-RADIATION. BE SURE TO OBSERVE ALL APPROPRIATE CAUTIONS.

As power is turned on, the carriage will cycle through its logic and return to the PARK position. Perform the following procedures to properly load the device:

a. Momentarily activate the cassette LOAD/PARK switch to bring carriage forward into the loading position.
b. Position the unexposed film cassette (lid of cassette facing up) into the loading area. With some types of cassettes it may be required to position each cassette in a certain way to provide the smoothest operation.
c. Gently slide the film cassette into the cassette tray assembly using the extended fingers of your hand until the film cassette securely latches within the tray as evidenced by an audible click of the latching mechanism. Proper framing of the exposed spotfilms can only be attained when the film cassette is properly locked and securely fastened within the tray. This will also prevent jamming. The cassette carriage should move back to the PARK/LOCK position.

In addition to the cassette carriage movement, all front panel pushbutton switches should light.

2. Select the fluoroscopic mode and use the foot switch to initiate a fluoroscopic exposure. The imaging system should activate and produce a blank display.

3. Engage all locks and attempt to reposition the SFD in all directions. This should not be possible.

4. Press the EJECT button. The SFD should eject the cassette.

5. Reload the cassette.

6. Select the one-on-one format.

7. Press and hold the PREPARE switch. The cassette should move forward to the EXPOSE position. Release the switch. The cassette should return to the PARK/LOCK position.
8. Select the two-on-one longitudinal format (split). Press and hold PREPARE, then press one of the X-RAY buttons. The SFD should make two exposures in rapid sequence before ejecting the cassette.
9. Repeat Step 7 for all splits. The SFD should make the appropriate number of exposures in all cases.
10. Activate the tabletop by pressing the positioning switches. Each switch should cause the tabletop to move in the direction indicated by its arrow.
11. Rotate the TABLE TILT control to the left. The table should tilt toward the head end.
12. Rotate the control to the right. The table should tilt toward the foot end.
13. Remove the tabletop.
14. Remove the four (4) knurled screws holding the collimator top cover and aluminum filter plate. Remove the cover and plate to gain access to the collimator shutters.
15. Operate both slide controls several times in each direction while observing the collimator. The shutter blades should open and close.
16. Reattach the aluminum filter plate and collimator top cover. Fasten securely using the four (4) knurled screws. Return the tabletop to its proper position.

3.2 POWER ASSIST CHECKOUT

The power assist handle not only controls horizontal motion of the tower, but also disengages the appropriate locks at the same time. By pulling the handle to the right and then left, K17, then K12 will be heard to actuate. See figures 5.3, 7.10 and drawing no. 70-08077, figure 10.4, page 10-10 (for locations of relays).

NO TEXT

SECTION 4.0

CALIBRATION

4.0 CALIBRATION

As the Spotfilm Device is entirely digital, no calibration potentiometers are used. Calibration of the collimator interfacing electronics is covered in separate documentation for the Eureka Linear™ FSE collimator..

The SFD and collimator circuitry are completely calibrated and aligned as a unit before leaving the factory. This calibration is critical to ensure that the SFD operates according to specifications and complies with all applicable regulations.

However, adjustments may be disturbed when the equipment is transported or during installation. Therefore, the service person(s) must confirm alignment of the SFD, X-ray table and tube.

As the SFD is generally mounted in a fixed location relative to the spotfilm tower, alignment is accomplished automatically when the tower is plumbed and aligned in accordance with the table manufacturer's instructions.

SECTION 5.0

OPERATION

5.0 OPERATION

Prior to operating this system, all personnel should be aware of, and keep in mind, the following warnings:

5.1 RADIATION PROTECTION

The primary and secondary radiation used and produced by this system can be dangerous to patients and operators unless safe exposure factors and procedures are strictly observed.

The primary beam of this system can produce serious, or possible fatal, injuries to persons in the adjacent area if it is improperly used. Precautions must always be taken to protect persons other than the patient being examined to exposure to the primary beam. Protective devices must be provided for personnel who must remain in an area where they could receive secondary radiation. Any object in the path of the primary beam produces this scattered type of radiation. The intensity of the secondary radiation is dependent upon the energy and intensity of the primary beam and on the atomic number of the object or material struck by the primary beam. Secondary radiation may be of greater intensity than that of the radiation reaching the film. Take protective measures to safeguard against it.

An effective protective measure is the use of lead shielding. To minimize dangerous exposure, use movable lead screens, lead impregnated gloves and lead impregnated aprons. These protective devices must contain a 0.25 millimeter thickness of lead or equivalent. Use such protective devices for all personnel exposed to radiation fields of 5 milliRoentgens per hour or more whether operators, observers, or servicing personnel.

Operators must be familiar with currently established safe exposure factors and procedures measurements, such as NCRP (National Council on Radiation Protection) Report 33 "Medical X-Ray and Gamma Ray Protections for Energies up to 10 MEV-Equipment Design and Use". They must also operate the equipment in compliance with this document.

Although X-radiation is hazardous, X-ray equipment poses little risk when it is properly used. Be certain that all service and operating personnel are properly informed and instructed of the hazards of radiation. Also, those responsible for the system must understand the safety requirements and special warnings for X-ray operation. Study this manual and all documents and warning labels associated with each component in the system to become aware of all the safety and operational requirements.

Failure to observe these warnings may cause serious or fatal injuries to the patient, operator, or other persons in the immediate area.

Patient positioning cannot be considered complete until the hand grips are attached to the table top and the patient has been instructed in their use. These grips provide extra safety by providing the patient with a safe handhold while the table top is being manipulated. Although the design of each X-ray table includes a maximum number of safety considerations, the hand grips provide an extra measure of safety often required to prevent an accident or injury.

5.2 MAXIMUM PERMISSIBLE DOSE

Studies on the effects of X-radiation have provided a basis for establishing the maximum permissible dose (MPD). The results of these studies have been used by the NCRP and the International Committee on Radiation Protection (ICRP) to develop MPD recommendations.

ICRP recommendations state that the MPD to the gonads, blood forming organs, lens of the eye, head, and trunk shall not exceed:

$\text{MPD} = 5 \times (n - 18)$ rems where n = age in years greater than 18

In addition, exposure shall not exceed 3 rems in any period of 13 consecutive weeks.

For hands, forearms, feet, and ankles, the recommended MPD is 75 rems in any one year.

5.3 MANUFACTURER'S RESPONSIBILITY

Although this equipment incorporates protection against X-radiation other than the useful beam, practical design does not provide complete protection. Equipment design does not compel the operator or assistants to take the necessary precautions, nor does it prevent the possibility of improper use which results in authorized or unauthorized persons from carelessly, unwisely or unknowingly exposing themselves or others to direct or secondary radiation. Allow only authorized, properly trained personnel to operate this equipment.

Be certain that all personnel authorized to use the equipment are aware of the danger of excessive exposure to X-radiation.

This Spotfilm Device is sold with the understanding that E.X.T. Inc., its agents and representatives, does not accept any responsibility for overexposure of patients or personnel to X-radiation.

Furthermore, E.X.T. Inc. does not accept any responsibility for overexposure of patients or personnel to X-radiation generated by this equipment which is a result of poor operating techniques or procedures.

Also, no responsibility will be assumed for any unit that has not been serviced and maintained in accordance with this manual, or which has been modified or tampered with in any way.

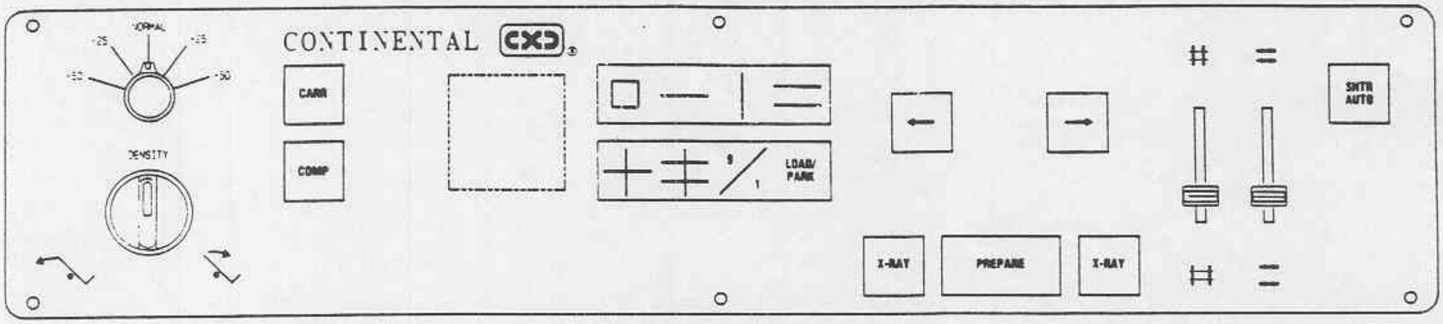
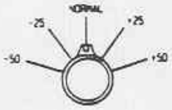

CONTINENTAL CXD
NORMAL
-25
+25
-50
+50
DENSITY
CARR
COMP
9
1
LOAD/PARK
X-RAY
PREPARE
X-RAY
SHTR AUTO

Figure 5.1

A CARR TRANSVERSE AND LONGITUDINAL LOCKS (PUSH ON, PUSH OFF)

B COMP COMPRESSION LOCK (PUSH ON, PUSH OFF)

C 
NORMAL
-25
+25
-50
+50
DENSITY CONTROL

D SHTR AUTO SHUTTER AUTO

E X-RAY X-RAY REQUEST FLUORO OR RADIOGRAPHIC WHEN IN PREPARE

F PREPARE PREPARE REQUEST

G_1 1 ON 1 FILM FORMAT

G_2 2 ON 1 FILM FORMAT

G_3 2 ON 1 FILM FORMAT

G_4 3 ON 1 FILM FORMAT

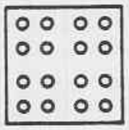
G_5 4 ON 1 FILM FORMAT

G_6 6 ON 1 FILM FORMAT

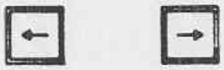
G_7 9 ON 1 FILM FORMAT

G_8 CASSETTE LOAD/PARK

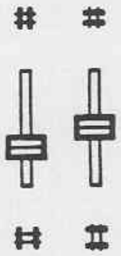
TABLE TILT CONTROL
H



FORMAT INDICATION (4 ON 1 FORMAT SHOWN)
I



TWO WAY TABLE TOP CONTROL
J



LONGITUDINAL MANUAL COLLIMATOR CONTROL
K

TRANSVERSE MANUAL COLLIMATOR CONTROL
L

FRONT PANEL CONTROLS AND INDICATORS
Figure 5.1

5.4 MONITORING OF PERSONNEL

Monitoring personnel to determine the amount of radiation to which they have been exposed provides a valuable cross check to determine whether or not safety measures are adequate. It may reveal inadequate or improper radiation protection practices and serious radiation exposure situations.

The most effective method of determining whether or not the existing protective measures are adequate is the use of instruments to measure the exposure in rads. This measurement should be taken at all locations where the operator, or any portion of his body may be during the exposure. Exposures must never exceed the accepted tolerable dose.

A common method of determining whether personnel have been exposed to excessive radiation is the use of film badges. These are X-ray sensitive films enclosed in badges which incorporate metal filters of varying degrees of transparency to X-radiation. Even though the devices only measure the radiation which reaches the area of the body on which they are worn, they do furnish an indication of the amount of radiation received.

5.5 PUSHBUTTON SWITCHES AND LED DISPLAY

Most SFD and system functions are under the control of 18 illuminated pushbutton switches on the front panel of the SFD. As Figure 5.1 shows, these switches are arranged in groups and keyed to the drawing by letter identifiers, according to function. Refer to Figure 5.1 as needed while reading the functional description in this subparagraph. (The letters in parentheses correspond with key letters shown in Figure 5.1.)

(A) CARR - Carriage (Transverse & Longitudinal Locks)

Switch A actuates the carriage locks. When switch A is pressed, its illumination increases to indicate that the transverse and longitudinal locks are engaged. Pressing it a second time decreases its light level while releasing the locks so that the SFD transverse and longitudinal positions can be changed.

(B) COMP - Compression Lock

Switch B controls the SFD compression lock. Pressing it causes its light level to increase, indicating that the compression lock is engaged. Pressing it again releases the lock so that the SFD can be repositioned vertically.

(C) Density

Rotary switch C provides automatic exposure control by varying mAs. It is calibrated in percentages of a reference gray scale.

(D) Shutter Auto

Lights to indicate automatic sizing to the full or selected portion size (spotfilm mode).

Pressing the pushbutton a second time sets the SFD to the manual mode. In this mode, the operator has control over the collimator aperture size with the use of controls M and N. Slide control M varies the opening of the head-foot (cephalocaudad - longitudinal) shutter blades and slide control N varies the opening of the front-back (transverse) blades. Both controls can be used together for simultaneous movement of the shutter blades.

Slide controls M and N always have control over the collimator aperture when the SFD is in the fluoro mode of operation. However, when the system is in the radiographic mode, the collimator aperture cannot be increased beyond the frame size for the selected format. The shutters are closed by sliding the controls up; sliding the controls down opens them.

(E) X-ray Request - Fluoro or Radiographic; and
(F) Prepare Request

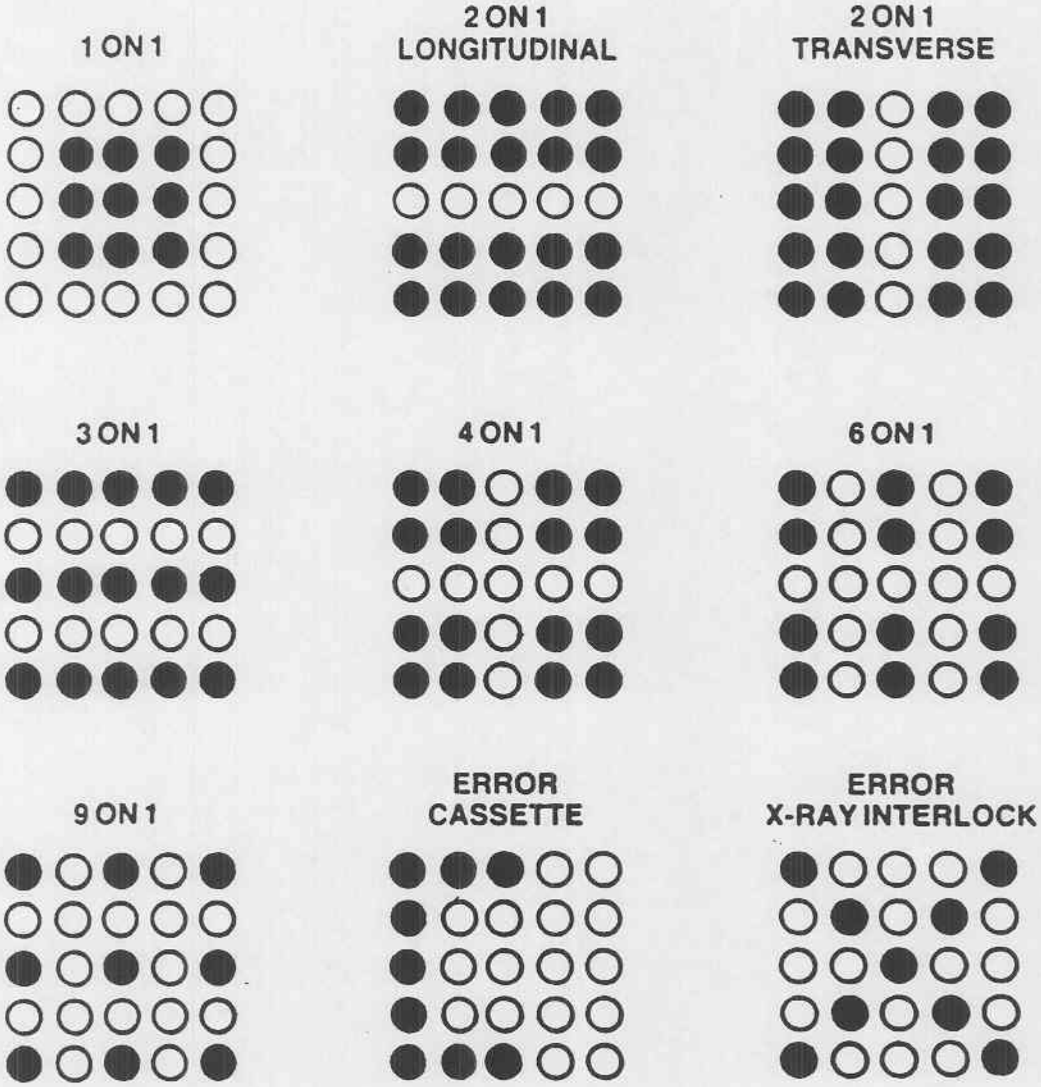
As it relates to SFD operation, pressing the PREPARE switch (H) causes the cassette to move from the rear, Park/Fluoro position into place for the next unexposed frame in the selected split. Releasing the switch allows the cassette to return to Park/Fluoro without exposing the film or advancing the frame. This means that PREPARE must be pressed and held while making exposures.

The PREPARE switch also performs the same functions as it would in any other radiographic system; it ensures that the X-ray tube rotor is up to speed, the filament voltage is at the proper level, unlocked locks are engaged, etc.

While PREPARE cannot initiate radiographic (spotfilm) exposures, it is used with either of the two X-ray switches (G). The PREPARE switch and one of the X-ray switches must be simultaneously pressed and held once for each exposure.

Occasionally, it may be necessary to interrupt a sequence. However, the SFD always "knows" its location on a given cassette during any radiological sequence. Therefore, it avoids double exposures by resuming with the next open frame after an interruption, provided that the cassette has not been ejected.

Pressing either X-ray switch or the foot switch WITHOUT pressing PREPARE initiates a fluoroscopic exposure that continues until the initiating switch is released.


1 ON 1
○○○○○
○●●●○
○●●●○
○●●●○
○○○○○
2 ON 1 LONGITUDINAL
●●●●●
●●●●●
○○○○○
●●●●●
●●●●●
2 ON 1 TRANSVERSE
●●○●●
●●○●●
●●○●●
●●○●●
●●○●●
3 ON 1
●●●●●
○○○○○
●●●●●
○○○○○
●●●●●
4 ON 1
●●○●●
●●○●●
○○○○○
●●○●●
●●○●●
6 ON 1
●○●○●
●○●○●
○○○○○
●○●○●
●○●○●
9 ON 1
●○●○●
○○○○○
●○●○●
○○○○○
●○●○●
ERROR CASSETTE
●●●○○
●○○○○
●○○○○
●○○○○
●●●○○
ERROR X-RAY INTERLOCK
●○○○●
○●○●○
○○●○○
○●○●○
●○○○●

FORMAT/STATUS DISPLAYS
Figure 5.2

(G) Format Selection Buttons

The SFD can make as many as nine exposures on a film cassette using any one of seven formats (splits) that can be selected before beginning an exposure sequence. Double exposures are prevented by microprocessor-controlled logic and cassettes can be ejected at any time during the exposure sequence. This logic circuitry also automatically controls aperture size when pushbutton F (automatic collimation) is lit.

Pressing pushbutton G_1 selects the one-on-one spotfilm format; pushbutton G_2 selects two-on-one longitudinal (head-foot); pushbutton G_3, two-on-one transverse (front-back); pushbutton G_4, three-on-one; pushbutton G_5, four-on-one; pushbutton G_6, six-on-one; and pushbutton G_7 selects the nine-on-one split. The light in each of these switches brightens while the switch is pressed.

Pressing switch G_8 causes the SFD to load and park a cassette. After the exposures have been made and the cassette parked, pressing this button again moves the cassette forward and out for ejection.

(H) Table Tilt Control

Table tilting is under the control of the spring-loaded, two-position, center-off rotary switch (J) at the lower left of the front panel. Rotating and holding this switch to the right causes the foot end of the table to tilt toward its maximum angle at a speed determined by the table mechanism. When the switch is released, it returns to its center-off position and table movement stops. The table then remains at the angle at which the switch was released until it is activated again.

Rotating the switch to the left causes the table's head end to tilt toward its maximum negative (Trendelenburg) angle. Releasing the switch again allows it to return to its center-off position and table movement stops.

Note that switch X only activates the table tilting mechanism - it does not affect its operating characteristics. As a result, the table's tilting speed and its maximum positive and negative tilting angles are determined by its mechanism.

(I) Format Indication

The SFD LED (light-emitting diode) display (I) provides a visual indication of the spotfilm format selected. As Figure 5.2 shows, it consists of 25 LEDs arranged in a 5 by 5 grid. The LEDs light as determined by the format selected, forming patterns that provide graphic displays. (Format selection is discussed in a later paragraph.) The LED(s) representing each frame in the selected split go out as the frame is exposed. The various graphic displays are shown in Figure 5.2.

The LEDs also produce two error displays, shown at the bottom right of Figure 5.2. The "C" display, "Error Cassette", indicates that there is no cassette in the carriage, all exposures in the selected format have been made, or that the cassette holder is empty in its forward position. The "X" display, "Error X-ray Interlock", indicates that the cassette is not locked in its forward position.

(J) Two Way Tabletop Control

The two outside momentary pushbuttons are provided for controlling a power tabletop. They allow for longitudinal movement.

(K) Longitudinal Manual Collimator Control

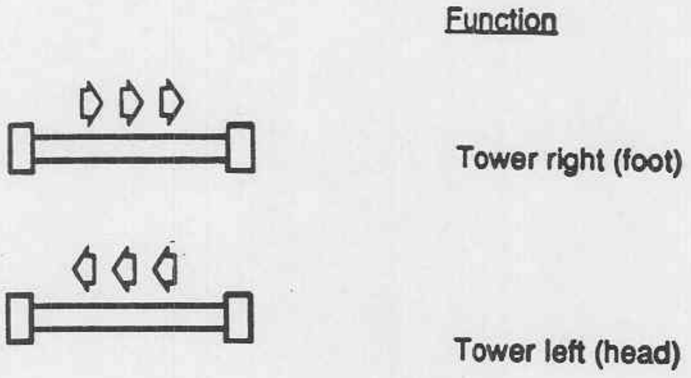
This control opens and closes the collimator shutters in the head-to-foot (cephalocaudad) direction.

(L) Transverse Manual Collimator Control

This control opens and closes the collimator shutters in the side-to-side (transverse) direction.

5.6 POWER ASSIST HANDLE

The power assist handle, the operation of which is shown in Figure 5.3, provides a convenient way to reposition the SFD, undertable X-ray tube, and collimator longitudinally with a minimum of effort. It accomplishes this by activating a power assist circuit for head-foot movement of the carriage. As an added convenience, it also automatically disengages the appropriate locks if they are engaged.



POWER ASSIST HANDLE OPERATION
Figure 5.3

A small amount of lateral pressure on the handle toward the left disengages the longitudinal locks if they are engaged (pushbutton A brightly lit) and activates the power assist circuit. This moves the SFD, tube, and collimator toward the head end of the table until the pressure is released. If the locks are engaged, releasing the pressure stops carriage motion and re-engages them. However, if pushbutton A is dimly lit (locks unengaged), the SFD carriage motion stops without re-engaging the locks.

Operation is similar for repositioning toward the foot end of the table. The only difference is that handle pressure is applied to the right.

WARNING

The vertical (compression) carriage allows the cone and SFD chassis to come in contact with patients, as is necessary for some procedures. However, in other procedures, such as myelograms, contact can be dangerous and result in serious patient injury. Therefore, it is vital that the myelographic stop be set on the tower to prevent the SFD from contacting the patient when these procedures are being performed.

5.7 MANUAL POSITIONING

The handle is also used for transverse positioning of the SFD. While this motion is not power assisted, using the handle to reposition the SFD automatically disengages the lock.

5.8 OPERATING PROCEDURES

Cassette Loading

1. Apply AC power. The carriage will cycle and return to the PARK position.
2. Momentarily activate the cassette LOAD/PARK switch to bring carriage forward into the loading position.
3. Position the unexposed film cassette (lid of cassette facing up) into the loading slot. With some types of cassettes it may be required to position each cassette in a certain way to provide the smoothest operation.
4. Gently slide the film cassette into the cassette tray assembly using the extended fingers of the hand until the film cassette securely latches within the tray as evidenced by an audible click of the latching mechanism. Proper framing of the exposed spotfilms can only be attained when the film cassette is properly locked and securely fastened within the tray. This will also prevent jamming.

Fluoroscopy with Spotfilming

To perform fluoroscopy with spotfilming, proceed as follows:

1. Move the device forward into the locked beam position.
2. Load an X-ray film cassette into the Spotfilm Device.
3. Select the desired spotfilm format.
4. Select the undertable (fluoro) tube on the generator control.
5. If phototiming of spotfilm exposure is desired, select spotfilm phototiming on the generator control.
6. Select the most desirable phototimer density on the generator control.
7. Select a backup radiographic time longer than the anticipated spotfilm exposure time. If the radiographic timer and not the phototimer terminates the spotfilm exposure, a buzzer at the generator will sound to verify exposure termination. In this situation the kVp and mA factors should be changed at the generator control to provide optimum spotfilm results.
8. Set the desired kVp and mA values on the Image Intensifier system control box or generator. Fluoroscopy may now be performed by depressing the X-ray button or fluoro foot switch. During the fluoroscopic examination, the tower, carriage, table top, and table may be moved, locked or unlocked, using the Spotfilm Device controls. During fluoroscopic examinations, manual adjustment of the X-ray beam area can be accomplished by operating the shutter levers on the Spotfilm Device.
9. When a spotfilm exposure is desired, depress the Spotfilm Device PREPARE pushbutton while depressing the fluoro foot switch. As the cassette leaves its parked position, all fluoro staging locks are automatically energized, and the collimator adjusts the X-ray beam area according to the spotfilm format selected and the shutter lever position. Also, the fluoro mA terminates and the X-ray generator changes to the spotfilm mode at the kVp, mA, and photo density (and radiographic backup time) previously selected. After the PREPARE pushbutton is released, the cassette is automatically transported back to the fluoroscopic (rear) position. If, however, a full spotfilm exposure is programmed, the cassette will remain in its rear Park position. For a spotfilm exposure, the letter "C" will be displayed after all selected portions are exposed, meaning no more exposures can be made on the cassette. If longitudinal or transverse halves or the spotfilm format were selected, re-operation of the PREPARE pushbutton will advance the cassette to the next exposure position and start the next spotfilm exposure.

Exposed Cassette Ejection

The following procedures are to be followed for removal of the exposed film cassette from the device. Partially exposed film cassettes may be ejected from the device whenever the LOAD/PARK button is depressed.

The film cassette may now be advanced forward to the Eject position for unloading. Perform the following procedures:

1. Position left or right hand below cassette entry/exit area with fingers below port and palm raised above slightly so as to catch cassette as it is driven forward by activating ADVANCE/RETURN switch with other hand. (If left hand is used to catch cassette, switch can be activated with right, and if right is used to catch cassette then the left hand can be used to activate the switch, whichever is more convenient to the operator.)

2. Grasp the partially ejected film cassette and remove it from the unloading area.

5.9 OPERATING DETAILS

Format Selection

Each available format can be selected at the beginning of a format selection as long as a radiographic exposure has not been performed. The cassette can be ejected at any time by depressing the LOAD/PARK button, at which time the operator can load a new cassette and select a new format. Double exposures are prevented by the microprocessor.

Collimator

The collimator allows the radiation field to be decreased or increased within the automatically regulated sizes. These sizes have preset limits determined by field size, either the image receptor and Mag mode or the selected portion (film size versus sequence selection). The system also closes or opens the collimator shutters to maintain the same effective X-ray beam size in relation to the field size whenever the Spotfilm Device is raised or lowered from the tabletop.

Collimator Mode Selection -

For collimation there are two operator selections: mode of operation and the Collimator Control switch. The 'AUTO COLL' button is pressed to select the Auto collimation mode, otherwise, the collimator is in the Manual mode. Pressing the button will alternate the selection and the Manual mode will be indicated by the extinguishing of the illuminated 'AUTO COLL' button. When in fluoroscopy, the collimator functions are identical for Auto and Manual Modes. The collimator will operate differently only when making a radiographic exposure.

Radiographic Exposure, Manual Mode

When the operator initiates PREPARE for a radiographic exposure in the Manual mode, the collimator automatically 'cones' the X-ray beam to the maximum allowable size for the field of view. This field of view is determined by the mode selection. When spotfilms have been selected the field of view is determined by the film size and the sequence selected.

When Photospot has been selected the field of view is determined by the image receptor and the magnification mode. If a cassette is loaded and a sequence selected, the collimator will use either the I.I., Mag mode, cassette size, or sequence size to determine the field of view, whichever is smallest. However, if the controls have been adjusted to produce an X-ray beam size smaller than that required for the field of view, or if the operator selection of a smaller size than the maximum allowable size was being used in the fluoro mode, the collimator shutter blades will remain at the smaller size. Pressing a Sequence Select button or Mag selection will not automatically adjust the shutter blades to produce an X-ray beam larger than the controls are adjusted for.

Radiographic Exposures, Auto Mode

When the operator initiates PREPARE for a radiographic exposure in the Auto mode, the collimator automatically 'cones' the X-ray beam to the maximum allowable size required for the field of view. This field of view is determined by the mode selection. When spotfilms have been selected the field of view is determined by the film size and the sequence selected. When Photospot has been selected the field of view is determined by the image receptor and the magnification mode. If a cassette is loaded and a sequence selected, the collimator will use either the I.I., Mag mode, cassette size, or sequence size to determine the field of view, whichever is smallest. However, if the controls have been adjusted to produce an X-ray beam size smaller than that required for the field of view, the Auto mode will change the field size to the maximum size required by the field of view as selected.

At the end of the exposure the collimator shutters will automatically adjust themselves back to the position selected by the collimator control switch.

Fluoroscopic Exposures, Both Modes

In both Manual and Auto modes, the collimator functioning remains the same. The 4-way collimator switch can be used to increase or decrease the field of view restricted only by preset limits determined by the image receptor. The field of view is automatically selected by the I.I. and the selected magnification mode. If a cassette is loaded and a sequence selected, the collimator will use either the I.I., Mag mode, cassette size, or sequence size to determine the field of view, whichever is smallest. The operator can reduce the field of view to any size smaller than the maximum allowable size down to the minimum allowable size. This restriction is in viewing only. The collimator shutters will follow the switch movement from the largest possible field of view to the smallest possible.

5.10 OPERATOR MAINTENANCE

In general, the Spotfilm Device requires little special care on the part of the user. Normal care in handling and operation of the apparatus should insure continuing satisfactory performance. Some considerations are listed here as a deterrent to possible equipment damage or failure. The general preventive maintenance procedures covered here must be performed on a regular monthly basis. X-ray equipment must be maintained in good operating order at all times to provide safe conditions for operating personnel and the patient.

CAUTION

The SFD contains no operator-serviceable parts. Therefore, refer all servicing to a qualified maintenance technician.

When inspecting the SFD, be sure to:

1. Check all nuts and bolts, screws, rivets, and other fasteners to ensure that they are tight. Also be sure that all fasteners are present and in good condition.
2. Test all front panel switches and the LED display for correct operation and to ensure that they light properly.
3. Inspect all electrical cables, cords, connectors, and fittings for tightness. Check for breaks in the insulation, abrasions, and other damage to cables and connectors. Pay particular attention to areas where electrical cabling enters housings or where it may be subject to stress from table positioning and other mechanical motions.
4. Examine all exterior painted or plated surfaces for evidence of deterioration, such as scratches, chipping, and corrosion. Make sure that all name plates and warning labels are present, legible and securely mounted.

5.11 OPERATIONAL TESTS

The operational tests in this subparagraph are also needed to ensure patient safety and ease of operation.

1. Exercise all SFD and table motions while paying attention to smoothness and ease of operation. Make sure that there is no difficulty of operation, squeaking or other unusual noises, or malfunction.
2. Engage all locks and attempt to reposition the SFD in all directions: it should not be possible. Slippage in any direction indicates that the associated lock is faulty or needs adjustment.

WARNING

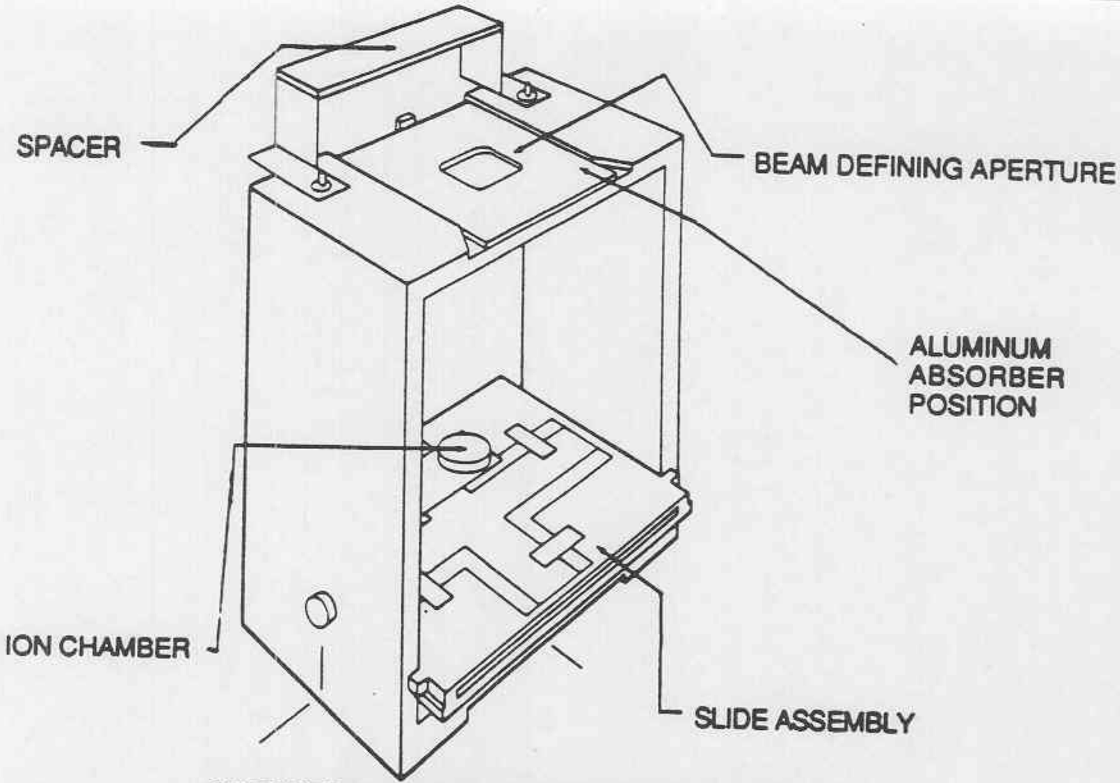
A faulty lock can cause serious patient injury. Therefore, do NOT use a system with malfunctioning locks until repairs have been completed.

5.12 CLEANING

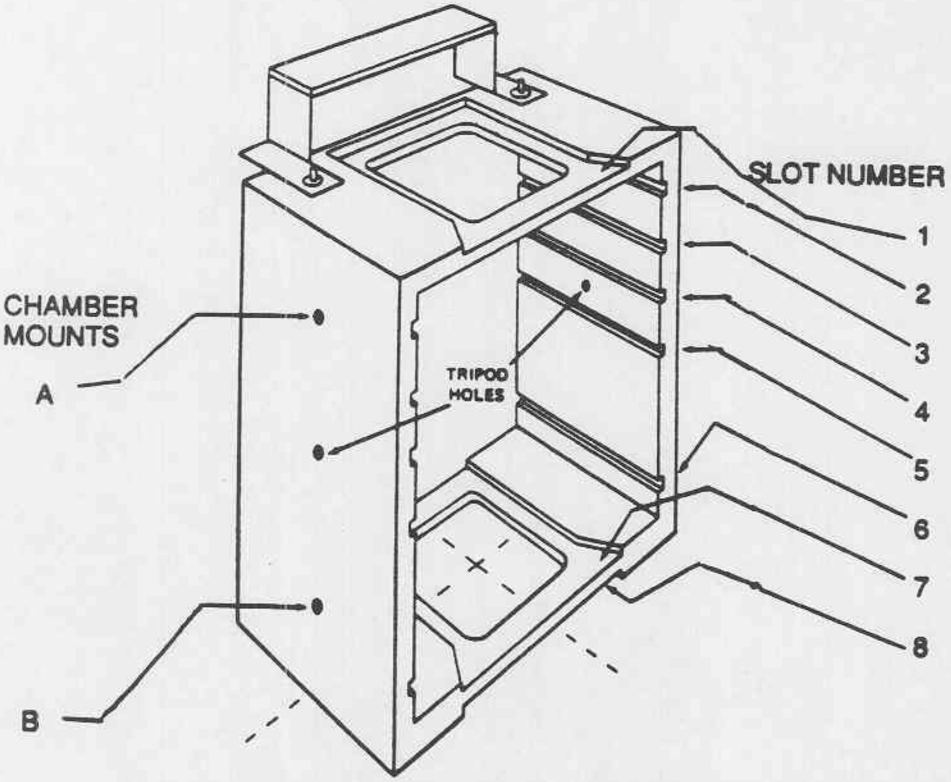
Spillage of any liquid on the SFD can cause a malfunction, particularly if it finds its way into the cassette carriage mechanism. This is especially so with liquids that leave a solid residue after they dry. Therefore, it is important to promptly remove spills with a soft cloth dampened in warm water. Regular cleaning can also be accomplished with a soft cloth, warm water, and a mild detergent.

SECTION 6.0

COMPLIANCE VERIFICATION


SPACER
BEAM DEFINING APERTURE
ALUMINUM ABSORBER POSITION
ION CHAMBER
SLIDE ASSEMBLY

CDRH/FDA COMPLIANCE TEST STAND
Figure 6.1


SLOT NUMBER
1
2
3
4
5
6
7
8
CHAMBER MOUNTS
A
TRIPOD HOLES
B

LEFT SIDE MOUNTING HOLES FOR COMPLIANCE TESTING

COMPLIANCE TEST STAND DETAIL
Figure 6.2

6.0 COMPLIANCE VERIFICATION

It is necessary for the assembler to verify compliance. A series of tests, when performed at the time of installation, will indicate compliance with 21CFR, Sub-Chapter J, Part 1020, Performance Standards.

The following tests are from the NEMA Standards Publication, No. XR 8-1979 (Test Methods for Diagnostic X-ray Machines for use during initial installation).

For each compliance item, there may be a variety of test methods described. Which method is used will depend on the tester's experience, availability of equipment or time. Any reference to tolerances on compliance items are referenced directly from 21CFR, Sub-Chapter J, Regulations. They do not take into account inaccuracies brought about by the test equipment, instrumentation, or the human element. These factors must be considered when these tests are performed and the compliance of the equipment is being determined.

6.1 VERIFICATION TESTS TO BE PERFORMED:

Test Procedure or Requirement	Applicable Paragraph
1. Minimum Field Size	XR8/2.16
2. X-ray Field Limitation and Alignment	XR8/2.20
3. Fluoro X-ray Field Limitation	XR8/2.24
4. Alignment of X-ray Edges (Spotfilm)	XR8/2.29
5. X-ray/IR Center Alignment (Spotfilm)	XR8/2.30

RECORD THE RESULTS ON THE *RECORD SHEET* SUPPLIED AT THE END OF THIS SECTION.

Radiation ☢ Warning for Diagnostic X-Ray Systems

X-rays are dangerous to both operator and others in the vicinity unless established safe exposure procedures are strictly observed.

The useful and scattered beams can produce serious, genetic or potentially fatal bodily injuries to any persons in the surrounding area if used by an unskilled operator. Adequate precautions must always be taken to avoid exposure to the useful beam, as well as to leakage radiation from within the source housing or to scattered radiation resulting from the passage of radiation through matter.

XR 8-2.16 MINIMUM FIELD SIZE

REQUIREMENT - Minimum field size at 100 centimeters (radiographic) or the maximum source-to-image distance (SID) (fluoroscopic) shall be less than or equal to 5 by 5 centimeters (See 21 CFR 1020.31 (d) (1), 1020.31 (e) (2), and 1020.32 (b) (2).)

.01 METHOD I - FILM METHOD

A. GENERAL

1. The following test is to be used for radiographic, fluoroscopic, and spotfilm devices.
2. This procedure need not be performed if it is apparent by visual means that the beam-limiting device can be adjusted to a size less than 5 by 5 centimeters at the specified SID.

B. EQUIPMENT

1. Cassette.
2. X-ray film or direct-print paper.

C. PROCEDURE 1 - RADIOGRAPHIC AND SPOTFILM DEVICES

1. Adjust the maximum SID obtainable (spotfilm devices or 100-centimeter radiographic devices).
2. Adjust the beam-limiting device to the smallest field size obtainable.
3. Load cassette and set proper technique factors.
4. Make an exposure.
5. Process film.

D. PROCEDURE 2 - FLUOROSCOPIC

1. Set fluoroscopic system for maximum SID and lock into position.
2. Remove all compression cones from the beam.
3. With the X-ray beam off, attach beam attenuator to the input surface of the image receptor.
4. Attach cassette to the bottom of the attenuator.
5. Close shutters as far as possible.
6. Set technique factors to assure proper exposure of the film.
7. Make exposure.

8. Process film.

E. VERIFICATION OF COMPLIANCE

Measure the X-ray field produced on film and verify that the field size is less than or equal to 5 by 5 centimeters.

NEMA Standard 5-15-1979

.02 METHOD II - VISUAL METHOD

A. GENERAL

1. The following tests are to be used for radiographic, fluoroscopic, and spotfilm devices.
2. These procedures need not be performed if it is apparent by visual means that the beam-limiting device can be adjusted to a size less than or equal to 5 by 5 centimeters at their specified source-to-image distance (SID).
3. These tests attempt to minimize radiation exposures as well as film processing by utilizing light-field visual display, or image display, or visual mechanical movement.

B. EQUIPMENT

Beam attenuator.

C. PROCEDURE I - RADIOGRAPHIC

1. Set the tube unit at a distance of 100 centimeters from the image receptor.
2. Pull out the bucky tray and place an unloaded cassette into the tray. *Do not reinsert bucky tray.*
3. Position source assembly over film cassette in the extended bucky tray.
4. Actuate the light-field and close shutters to minimum size. If the light is completely blocked from the image receptor, no further test is required.
5. Measure the light-field size on the cassette of the extended bucky tray.

D. VERIFICATION OF COMPLIANCE

Measured field size must be less than or equal to 5 by 5 centimeters.

E. PROCEDURE 2 - SPOTFILM/FLUOROSCOPIC

1. Set SID for maximum obtainable and lock in place.
2. Position beam attenuator to intercept entire X-ray beam.
3. Set appropriate technique factors (both spotfilm and fluoroscopic).
4. Close shutters to smallest size obtainable and make an exposure.

5. Verify on viewing device that there is no visual indication of radiation. If any radiation field is discernible, Method I must be utilized to determine minimum field size.

F. VERIFICATION OF COMPLIANCE

Verify that no visual indication of the radiation field is discernible.

NEMA Standard 5-15-1979

XR 8-2.20 X-RAY FIELD LIMITATION AND ALIGNMENT

REQUIREMENT - The X-ray field size in the plane of the image receptor, whether automatically or manually adjusted, shall be such that neither the length nor the width of the X-ray field differs from that of the image receptor by greater than 3 percent of the source-to-image distance (SID) and that the sum of the length and width differences without regard to sign be no greater than 4 percent of the SID, when the equipment indicates that the beam axis is perpendicular to the plane of the image receptor. (See 21 CFR 1020.31 (e) (2) (ii).)

.01 METHOD I - FDA/CDRH TEST STAND METHOD

A. EQUIPMENT

1. FDA/CDRH compliance test stand with accessories.
2. Slide assembly.
3. Plastic cassette containing a sheet of direct-print paper or X-ray film.
4. Ruler.
5. Cassette (preferably 8 by 10 inches or smaller).

B. PROCEDURE

1. Using the means provided, align the source assembly such that the beam axis is perpendicular to the image receptor.
2. Place the test stand on the table.
3. Position the spacer so as not to intersect the primary beam and secure with the pushbutton connectors.
4. Center the source assembly over the test stand using the means provided, e.g., the light-field used to define the X-ray field.
5. Bring the source assembly down into firm contact with the spacer.
6. Center the cassette tray with the source assembly using the means provided, e.g., bucky light.
7. Insert the plastic cassette into the slide assembly. Then insert the slide assembly into slot 5. (See Fig. 6.2.)

8. Center the film cassette in the cassette tray and insert into position. If the positive-beam limitation will not operate at this SID, raise the source assembly and lock in position at the first operable SID.

9. Make an exposure. Develop the image. Measure and record the length and width dimensions of the image.

10. Calculate the field size correction factor as the SID/A where:

    a. SID is the indicated source-to-image receptor distance, and;

    b. A is the indicated source-to-tabletop distance less 7.7 inches. Multiply each of the measured dimensions by the correction factor.

    X-ray field length at

    under-table image receptor $= \frac{SID}{A} \times$ (X-ray field length at slot 5)

    X-ray field width at

    under-table image receptor $= \frac{SID}{A} \times$ (X-ray field width at slot 5)

    Determine the difference without regard to sign between the corrected length and width dimensions and the corresponding cassette film size dimensions (8 by 10, 5 by 7, etc.). Each of these differences must be less than 3 percent of the SID, and the sum of these differences must be less than 4 percent of the SID.

    NEMA Standard 5-15-1979

.02 METHOD II - ALTERNATE TEST STAND METHOD

A. GENERAL

Prior to performing this test the magnification factor must be determined in accordance with the X-ray/Light-Field Alignment Test - Method III.

B. EQUIPMENT

1. Manufacturer's recommended test stand.

2. Cassette with film.

C. PROCEDURE

1. Align the tube unit and image receptor and set SID to the value determined in the actual versus indicated SID test.

2. Insert empty 8 by 10 inch cassette into bucky tray.

3. Position test stand in accordance with manufacturer's instructions.

4. Load a second cassette and place in the designated position.
5. Select the proper technique factors, make an exposure, and develop film.
6. Measure the length and width of the X-ray image on the film.
7. Multiply each measurement by the magnification factor previously determined.

D. VERIFICATION OF COMPLIANCE

Verify that the X-ray field size in the plane of the image receptor does not differ from that of the image receptor by greater than 3 percent of the SID and that the sum of the length and width differences without regard to sign is not greater than 4 percent of the SID.

NEMA Standard 5-15-1979

03. METHOD III - CASSETTE METHOD

A. GENERAL

This procedure can be used only when a capability is provided for overriding positive-beam limitation.

B. EQUIPMENT

1. Large cassette with film.
2. Small cassette, empty.

C. PROCEDURE

1. Insert empty smaller cassette into bucky tray.
2. Switch system to the override mode.
3. Remove the smaller cassette and insert the loaded large cassette.
4. Select the proper technique factors, make an exposure, and develop film.
5. Measure the length and width of the X-ray image on the film.

D. VERIFICATION OF COMPLIANCE

Verify that the X-ray field size in the plane of the image receptor does not differ from that of the image receptor (smaller cassette) by greater than 3 percent of the SID and that the sum of the length and width differences without regard to sign is not greater than 4 percent of the SID.

NEMA Standard 5-15-1979

XR 8-2.24 FLUOROSCOPIC X-RAY FIELD LIMITATION

REQUIREMENT

A. NONIMAGE-INTENSIFIED FLUOROSCOPY

The X-ray field by nonimage-intensified fluoroscopic equipment shall not extend beyond the entire visible area of the image receptor. This requirement applies to field size during fluoroscopic procedures.

B. IMAGE-INTENSIFIED FLUOROSCOPY

1. During fluoroscopic procedures, neither the length nor the width of the X-ray field in the plane of the image receptor shall exceed the visible area of the image receptor by more than 3 percent of the source-to-image distance (SID). The sum of the excess length and the excess width shall be no greater than 4 percent of the SID.

2. Compliance shall be determined with the beam axis perpendicular to the image receptor. For rectangular X-ray fields used with circular image receptors, the error in alignment shall be determined along the length and width dimensions of the X-ray field which pass through the center of the visible area of the image receptor. (See 21 CFR 1020.32 (b).)

.01 METHOD I - FDA/CDRH TEST STAND METHOD

A. EQUIPMENT

1. FDA/CDRH compliance test stand and accessories.
2. Brass or copper attenuation block.
3. Plastic cassette and direct-print paper or redipack film cassette.

B. PROCEDURE

1. Position all movable grids and compression cones out of the path of the primary beam. If necessary, level the table and retract the spotfilm carriage. If the system utilizes a television monitor, turn it on and allow time for warmup.
2. Place the test stand in the approximate center of the table.
3. Insert the slide assembly, grid side down, into slot 5 (See Fig. 6.2.)
4. Place attenuator block on top of slide assembly.
5. Fully open the beam-limiting device.
6. Center the image receptor over the test stand by observing the image of the grid on the image receptor.
7. Bring the imaging assembly down into firm contact with the top of the stand.

8. If using a dual-field image intensifier, e.g., 6- and 9-inch capability, select the mode of largest image magnification, e.g., 6-inch mode in this case.

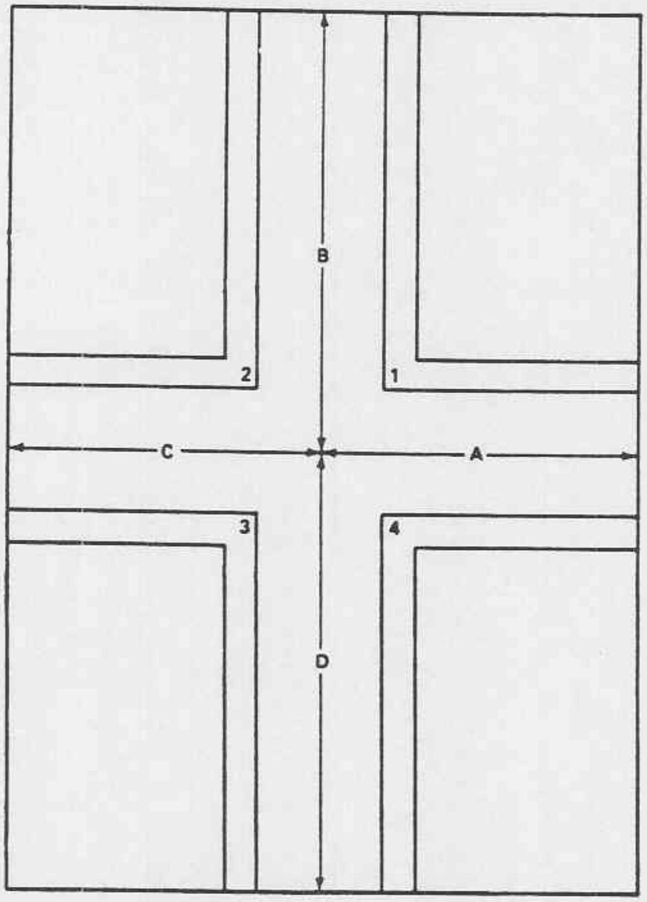
9. Adjust the controls to obtain the best quality image.

10. Insert a plastic cassette containing a sheet of direct-print paper or redipack film cassette into the slide assembly and make an exposure.

11. At the image output, count the units from the center of the grid to each edge of the image as shown by lines A, B, C, and D of Fig. 6.3.
    Note that line A passes between grid numbers 1 and 4, B passes between numbers 1 and 2, etc. Record the measurements in order.

12. Develop the film and outline the perimeter of the image.

13. Count the units from the center of the grid to each edge as you did with A, B, C, and D, above. Record these as A'. B'. C', and D'.



FLUOROSCOPIC X-RAY FIELD LIMITATION, TEST STAND METHOD
Figure 6.3

C. VERIFICATION OF COMPLIANCE

For compliance of nonimage-intensified systems, A shall be less than or equal to A', B shall be less than or equal to B', C shall be less than or equal to C', and D shall be less than or equal to D'.

For image-intensified systems, determine the source-to-slot-5 distance by adding 18.5 centimeters (7.3 in) to the minimum source-to-skin distance (SSD) determined by the SSD test procedure using the FDA/CDRH test stand. Calculate and record 3 percent and 4 percent of this distance. Determine the difference, without regard to sign, of A and A', B and B', C and C', and D and D'. Sum the differences. They must be less than or equal to 4 percent of the source-to-slot-5 distance. In addition, the sum of the A and A' plus the C and C' differences and the sum of the B and B' plus D and D' differences must each be less than or equal to 3 percent of the source-to-slot-5 distance.

.02 METHOD II - DIRECT METHOD

A. EQUIPMENT

1. Lead foil phantom or copper attenuator.
2. Direct-print paper.
3. One- by 1-inch steel marker.
4. Four additional metal markers (each marker is approximately 1/32-inch galvanized sheet metal having the dimensions of 1.5 by 0.5 inches).

B. PROCEDURE - NONIMAGE-INTENSIFIED FLUOROSCOPE

1. Place the image receptor as close as possible to the tabletop.
2. Open the shutters to the maximum and activate the fluoroscopic tube.
3. Slowly increase the distance between the tabletop and the image receptor. The unit is in compliance if, at the greatest extension of the image receptor, there is an unilluminated border all around the visible area of the image receptor. No further tests need be made.
4. If the illuminated area expands to the edges of the visible area of the image receptor, lower the image receptor until there is a small unilluminated border.
5. Close the shutters to produce approximately a 2-inch wide unilluminated border. Resume increasing image-receptor-to-tabletop distance. The unit is not in compliance if the illuminated area continues to expand.
6. If the illuminated area does not expand, then at the maximum SID, slowly open the shutters to the maximum. The unit is in compliance if the illuminated area does not expand.

C. PROCEDURE - IMAGE-INTENSIFIED FLUOROSCOPE (Under-the-table Tube, Variable Collimator)

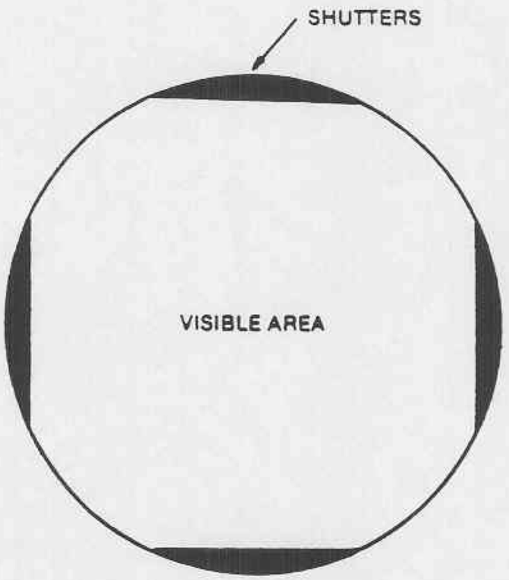
1. Attach a beam attenuator to the bottom of the image receptor housing. Raise the image receptor housing to its greatest SID and close the shutters to the fullest extent. Activate the tube and slowly increase the field size while observing the monitor. If at the maximum field size it is obvious that the image of the beam-limiting device is apparent at the edge of the image receptor, no further test need to be made. (See Fig. 6.4.)
2. Place markers on tabletop, continue to activate the tube intermittently, and between exposures move the markers to the edges of the visible area of the image receptor (Fig. 6.5).
3. Place a 1- by 1-inch steel marker on the tabletop approximately centered between the markers.
4. Center a cassette loaded with direct-print paper or redipack over the markers. Attach a second cassette to the bottom of the beam attenuator, adjust the image receptor to 30 centimeters (12 in) above the tabletop or the minimum beam attenuator-to-tabletop distance, whichever is greater, and center it over the bottom cassette (Fig. 6.6). Measure the distance.
5. Activate the tube for an appropriate exposure of direct-print paper or the redipack film.
6. Develop the direct-print papers or the films. Measure the length of the marker image on the upper sheet. Calculate the distance from the tabletop to the source by the similar triangle method. Use this distance as the SID in the next step (7).
7. On the lower sheet measure the distance from the edges of the exposed area to the outer edge of the marker. Calculate the percent of the SID of the X-ray field in excess of the visible area.
8. Place the radiopaque markers at right angles to the original position and repeat the procedure.

D. VERIFICATION OF COMPLIANCE

For nonimage-intensified fluoroscopy, verify that the X-ray field does not extend beyond the visible area of the image receptor.

For image-intensified fluoroscopy, verify that neither the length or width misalignment exceeds the visible area of the image receptor by more than 3 percent of the SID. The sum of the excess length and the excess width shall be no greater than 4 percent of the SID.

NEMA Standard 5-15-1979


SHUTTERS
VISIBLE AREA

FLUOROSCOPIC X-RAY FIELD LIMITATION, DIRECT METHOD
Figure 6.4

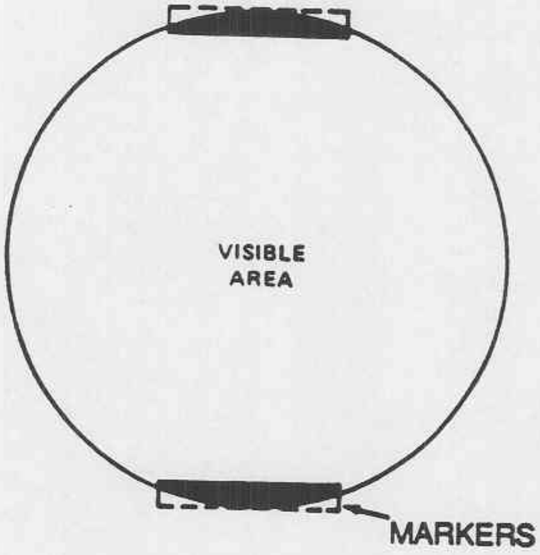
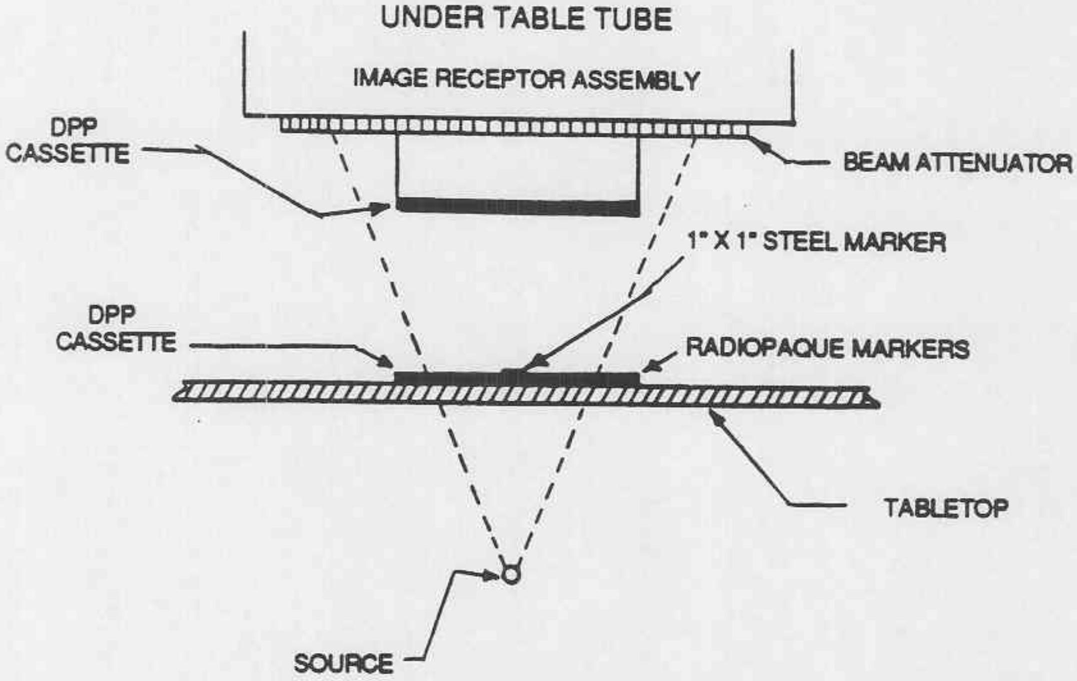

VISIBLE
AREA
MARKERS

IMAGE INTENSIFIED FLUOROSCOPE, METAL MARKER METHOD, OUTSIDE EDGE
Figure 6.5


UNDER TABLE TUBE
IMAGE RECEPTOR ASSEMBLY
DPP CASSETTE
BEAM ATTENUATOR
1" X 1" STEEL MARKER
DPP CASSETTE
RADIOPAQUE MARKERS
TABLETOP
SOURCE

UNDERTABLE TUBE, TEST SET-UP
Figure 6.6

XR 8-2.29 ALIGNMENT OF X-RAY FIELD EDGES TO SELECTED PORTIONS OF THE IMAGE RECEPTOR

REQUIREMENT - The misalignment of the X-ray field with that portion of the image receptor selected on the spotfilm device, along either the length or the width dimension, shall not exceed 3 percent of the source-to-image-receptor distance (SID), and the total misalignment without regard to sign along both dimensions shall not exceed 4 percent of the SID. (See 21 CFR 1020.31 (g).)

A. GENERAL

Technique factors must be selected for a film density of approximately 1.0.

B. EQUIPMENT

1. Manufacturer's recommended test stand.
2. Graduated template.
3. Two cassettes.
4. Film.

C. PROCEDURE

1. Verify by the means provided that the axis of the X-ray beam is perpendicular to the plane of the image receptor (applicable only where variable beam angulation is provided).
2. Load the cassette with film and place in the spotfilm device.
3. Position test stand in accordance with manufacturer's instructions.
4. Load a second cassette with film and place in the designated position on the test stand. *This film must be large enough to accept a one-on-one format.*
5. Place graduated template in a position between the X-ray source and the two cassettes.
6. Select proper technique factors and a one-on-one spotfilm format.
7. Make an exposure and develop films.
8. Repeat steps 1 through 7 for each available spotfilm format.

D. CALCULATIONS

1. Calculate the magnification factor by measuring the distance between the same two points on the graduated template image on each of the two films. The two points chosen must be as far apart as possible. Divide the smaller measurement into the larger measurement to determine the magnification factor.

2. If the source-to-test stand film distance is known, calculate the actual SID by multiplying the magnification factor by the known source-to-test film distance.

3. If the source-to-test stand film distance is not known, measure the actual distance from the graduated template position to the test stand film plane (distance Z, see Fig. 6.7).

4. Calculate the source-to-template distance (distance X) using the following formula:

$$\frac{A}{B} = \frac{X}{X + Z} \text{ or } X = \frac{A\,Z}{B - A}$$

where:

A = two points on a graduated template.

B = magnification of the same two points on the graduated template as used in A.

5. Calculate the source-to-test stand film distance by adding distance X and distance Z. Multiply the source-to-test stand film distance by the magnification factor determined in step 1 to determine the actual SID.

6. On the test stand film measure and record distances a, b, c, and d from the center of the graduated template to each respective edge of the radiographic image (see Fig. 6.8).

7. Multiply each distance a through d by the magnification factor and record the products as a', b', c', and d'. Note that a', b', c', and d' are the respective distances they would have been if they had been recorded at the spotfilm plane.

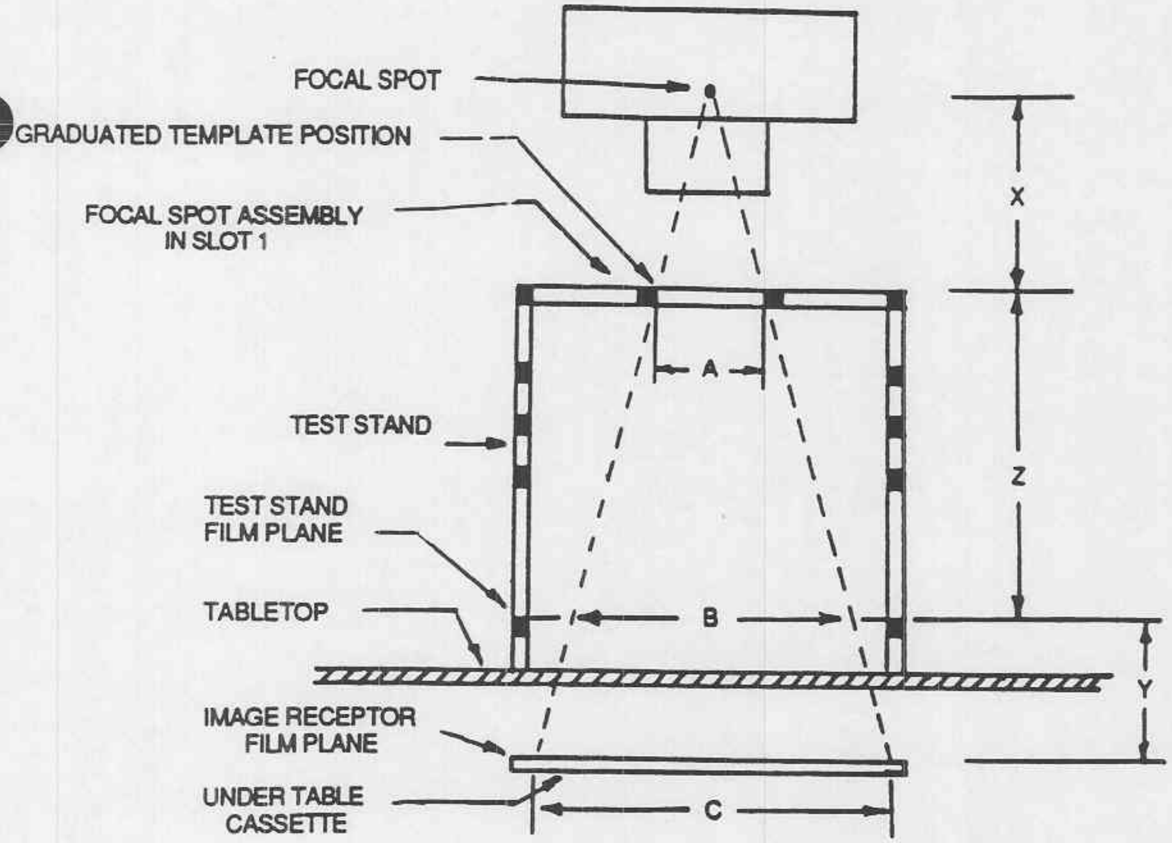
8. On the spotfilm image measure distances A, B, C, and D from the center of the graduated template image to each respective edge of the selected portion of the spotfilm (see Fig. 6.9). Record distances A, B, C, and D as measured.

9. Calculate the length differences and width differences without regard to sign as follows:

$$\text{Length difference} = |B - b'| + |D - d'|$$

$$\text{Width Difference} = |A - a'| + |C - c'|$$

Record the sum of the length and width differences.


FOCAL SPOT
GRADUATED TEMPLATE POSITION
FOCAL SPOT ASSEMBLY IN SLOT 1
TEST STAND
TEST STAND FILM PLANE
TABLETOP
IMAGE RECEPTOR FILM PLANE
UNDER TABLE CASSETTE
X
A
Z
B
Y
C

EXAMPLE:

Let A = 2

$B = 3\frac{3}{8} = \frac{27}{8} = \frac{54}{16}$

$C = 3\frac{13}{16} = \frac{61}{16}$

$Z = 14\frac{7}{16} = \frac{231}{16}$

$X + Z = 21 + 14\frac{7}{16}$

$= 35\frac{7}{16} = \frac{567}{16}$

$X + Z + Y = 35\frac{7}{16} + 4\frac{19}{32}$

$= 40\frac{1}{32}$

$$\frac{A}{B} = \frac{X}{X + Z}$$

$$\frac{2}{\frac{27}{8}} = \frac{X}{X+\frac{231}{16}}$$

$$2X + \frac{231}{8} = \frac{27X}{8}$$

$$\frac{231}{8} = \frac{27X}{8} - \frac{16X}{8}$$

$$\frac{231}{8} \cdot \frac{8}{11} = X$$

$$X = 21$$

$$\frac{B}{C} = \frac{X + Z}{X + Z + Y}$$

$$\frac{\frac{54}{16}}{\frac{61}{16}} = \frac{\frac{567}{16}}{\frac{567}{16} + Y}$$

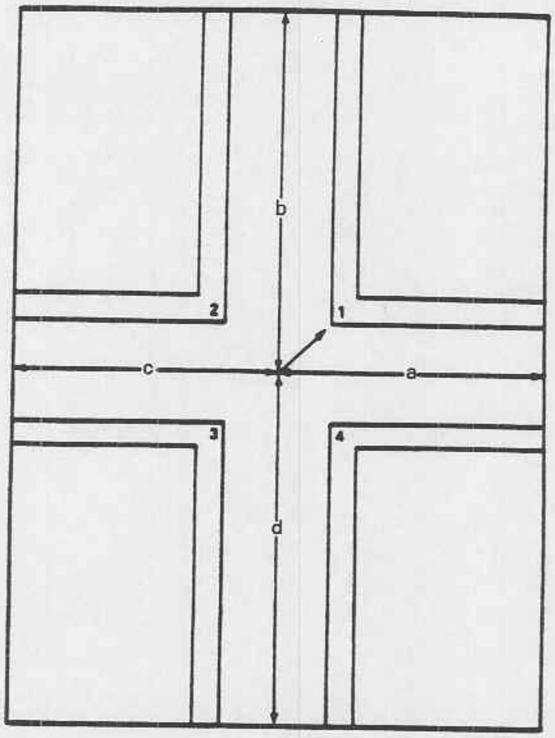
$$\frac{54}{16} \cdot \frac{567}{16} + \frac{54Y}{16} = \frac{567}{16} \cdot \frac{61}{16}$$

$$\frac{54Y}{16} = \frac{567}{16}\left(\frac{61}{16} - \frac{54}{16}\right)$$

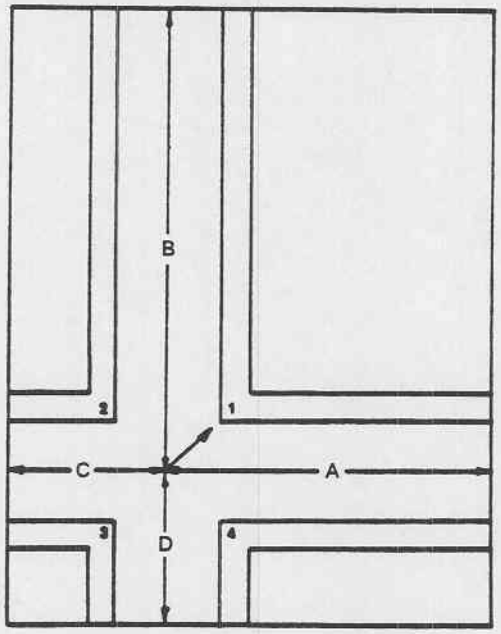
$$Y = \frac{567}{16} \cdot \frac{7}{16} \cdot \frac{16}{54}$$

$$Y = 4\frac{19}{32}$$

DETERMINATION OF SID
Figure 6.7



SPOTFILM X-RAY FIELD LIMITATION, TEST STAND METHOD, OUTSIDE EDGE
Figure 6.8



SPOTFILM X-RAY FIELD LIMITATION, TEST STAND METHOD, ACTUAL
Figure 6.9

E. VERIFICATION OF COMPLIANCE

1. Calculate 3 and 4 percent of the actual SID and record.

   The individual length and width misalignment, regardless of sign, must be less than or equal to 3 percent of the SID as calculated in step 1. The summation of the length and width misalignments, regardless of sign, must be less than or equal to 4 percent of the SID as calculated in step 1.

   NEMA Standard 5-15-1979

XR 8-2.30 ALIGNMENT OF CENTER OF X-RAY FIELD TO CENTER OF SELECTED PORTION OF IMAGE RECEPTOR

REQUIREMENT - The center of the X-ray field in the plane of the film shall be aligned with the center of the selected portion of the film to within 2 percent of the source-to-image distance (SID). (See 21 CFR 1020.31 (g) (4).)

A. GENERAL

1. All exposures taken during this test should have a uniform film density of approximately 1.0.
2. The actual SID must be determined prior to performing this test.

B. EQUIPMENT

Radiographic cassette and film.

NO TEXT

SECTION 7.0

MAINTENANCE/REPAIR

7.0 MAINTENANCE/REPAIR

7.1 CORRECTIVE MAINTENANCE

The SFD is a reliable, relatively simple mechanical device that rarely requires corrective maintenance. Although component failures are rare, ease of access for maintenance was an important consideration in its design. This keeps "down time" to a minimum, since most components can be rapidly replaced.

Following are instructions, keyed to detail drawings, for replacement and adjustment of most of the components and assemblies. Most of these straightforward procedures require a minimum of disassembly and can be performed with a basic complement of common hand tools.

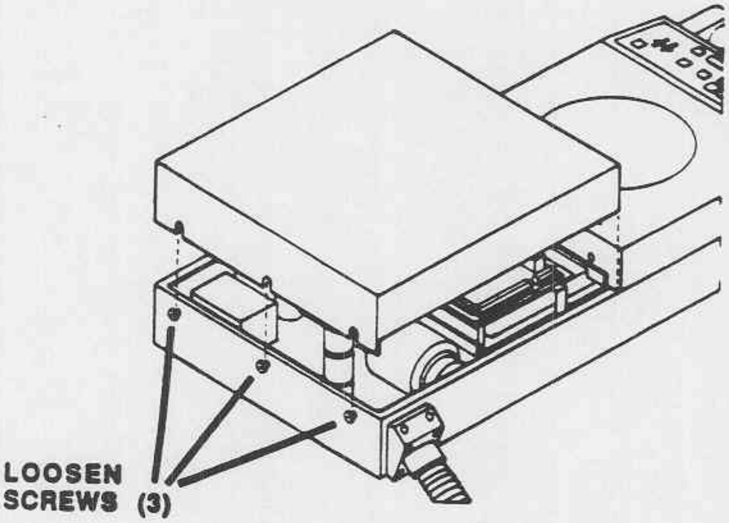
Hand Tools Required
Slotted screwdriver
Pocket screwdriver
No. 2 Phillips screwdriver
Set of nutdrivers or 6" adjustable wrench
Set of hex key ("Allen") wrenches

NOTE: The use of Loctite™ #232 thread locking compound is recommended for use on those assemblies that are subject to stress or vibration, such as the Brake/Clutch Assembly, Motor Bracket and any adjustment screws and locknuts on the cassette carriage.

7.2 REAR COVER REMOVAL AND REPLACEMENT (See Figure 7.1)

1. Loosen the three screws securing the rear cover to the chassis.

2. Lift the rear of the cover approximately one inch (25 mm) to disengage the flange at the front. Slide the cover about 1/4 inch (6 mm) toward the rear. Lift off and set aside in a safe place.



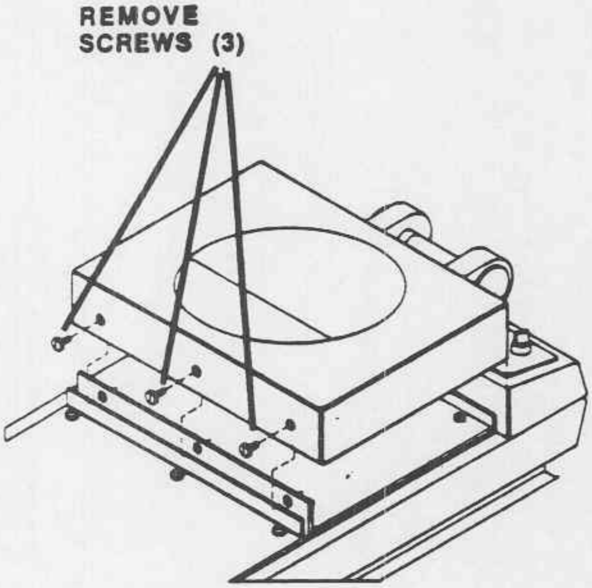
REAR COVER REMOVAL
Figure 7.1

7.3 FRONT COVER REMOVAL (for access to sensor adjustments)

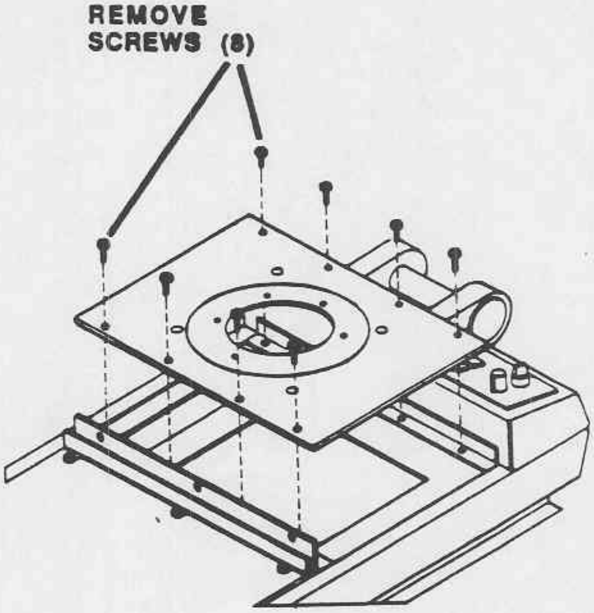
1. Remove the imaging system following the instructions provided by the manufacturer.
2. Remove the front cover by removing the three screws securing the rear lip to the chassis. Lift the cover up and back to disengage the front studs. See Figure 7.2.
3. Remove the imaging system adapter plate by removing the eight screws securing it to the SFD and lifting it from the chassis. See Figure 7.3.

WARNING!

WHEN REASSEMBLING, BE SURE TO FASTEN THE IMAGING SYSTEM ADAPTER PLATE SECURELY. USE LOCTITE™ #232 ON THE SCREW THREADS AFTER THOROUGHLY CLEANING OFF ANY OIL OR GREASE.



FRONT COVER REMOVAL
Figure 7.2



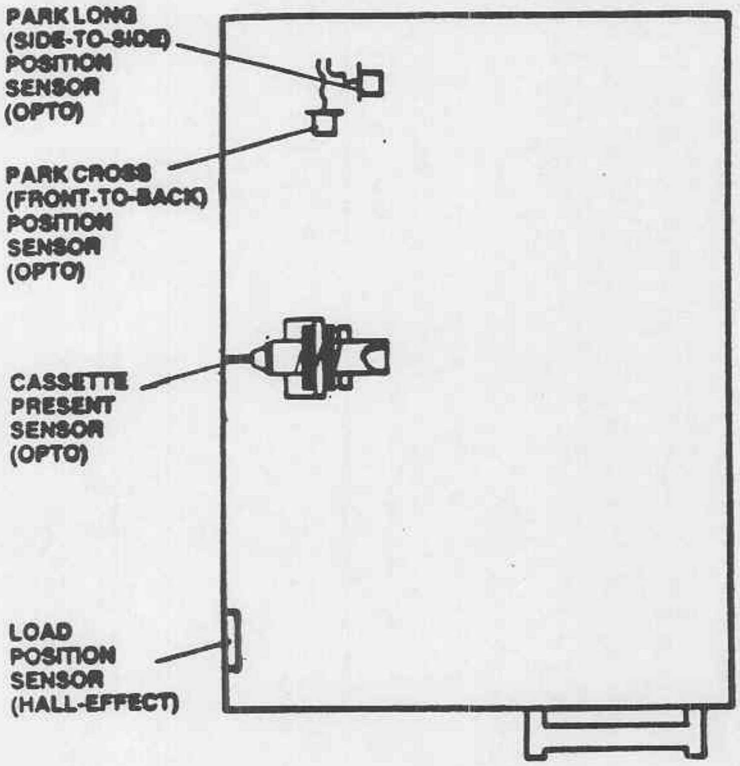
I.I. ADAPTER PLATE REMOVAL
Figure 7.3

7.4 POSITION SENSING

The spotfilm device uses a combination of a Hall Effect and three optoelectronic (opto-interrupter) sensors in the chassis. Additionally, the Power Assist Handle uses opto-interrupters (two each) at each end. The chassis-mounted sensors are used for internal interlocking, while the handle-mounted sensors are used to control external power assists, for spotfilm device vertical, and tower horizontal motion. As both types of sensor, which can be considered functionally equivalent to switches, involve no contact with moving parts, reliability is greatly enhanced over miniature snap-action switches. Consequently, failures are extremely rare and when the functions are understood, can be quickly diagnosed.

7.5 ADJUSTMENT OF CHASSIS SENSORS

Figure 7.4 below shows the locations of the chassis-mounted sensors, their functions, and the connection points on the Interface Board headers for voltmeter checks:


PARK LONG (SIDE-TO-SIDE) POSITION SENSOR (OPTO)
PARK CROSS (FRONT-TO-BACK) POSITION SENSOR (OPTO)
CASSETTE PRESENT SENSOR (OPTO)
LOAD POSITION SENSOR (HALL-EFFECT)

Terminal	Condition	Reading
+J6-9, -J6-2	Cassette IN, 4-on-1 format	low (≃ 0V.)
+J6-12, -J6-2	Cassette OUT, or 1-on-1, 2-on-1 (long), 3-on-1	high (≃ 5V
+J6-15, -J6-2	Cassette OUT, 4-on-1 format	low (≃ 0V.)
	Cassette IN, Any format	high (≃ 5V.)
+J5-6, -J6-2	Cassette OUT, or Fully Loaded	low (≃ 0V.)
	Cassette Loading	momentary high (≃ 5V.)

CHASSIS SENSOR LOCATIONS
Figure 7.4

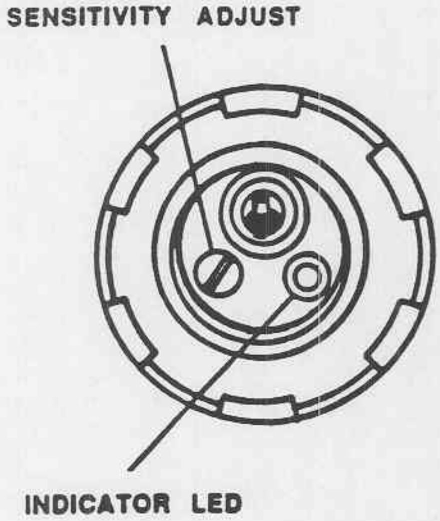
With the exception of the Cassette Present Sensor, which is in a fixed location, but with an electronic sensitivity adjustment (see Figure 7.5), the other three are mounted on adjustable brackets. See Figures 7.6 and 7.7 for locations of the adjustments. Adjustments should not be necessary unless a bracket is inadvertently bent or if a switch has been replaced. The Cassette Present Sensor is adjusted for sensitivity by turning the screw on the top surface until the LED just lights. (This is done with no cassette in the tray, so that the honeycomb diffuser decal is visible to the sensor.) Table 7.1 below shows typical symptoms of misadjustment and the procedures to be used in re-adjustment:

SYMPTOMS, CAUSES, AND CURES FOR CHASSIS SENSORS

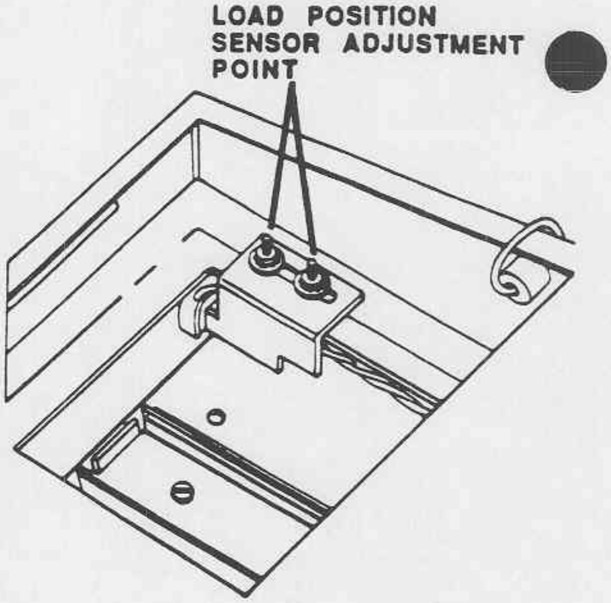
Table 7.1

Symptom	Cause	Cure
With cassette locked in place, "J" indication on front panel.	Load Position Sensor defective or misadjusted; magnet too far from sensor.	Replace sensor; loosen mounting screws, readjust; unscrew magnet from locknut to move closer to sensor.
With no cassette loaded, carriage advances to "Expose" position, allows exposures.	Cassette Present Sensor defective or misadjusted.	Replace sensor; adjust sensitivity pot.
Spotfilm images out of registration with fluoro image in CROSS* direction.	Cross Park Position Sensor defective; bracket bent.	Replace sensor; adjust bracket.**
Spotfilm images out of registration with fluoro image in LONG* direction.	Long Park Position Sensor defective; bracket bent.	Replace sensor; adjust bracket.**

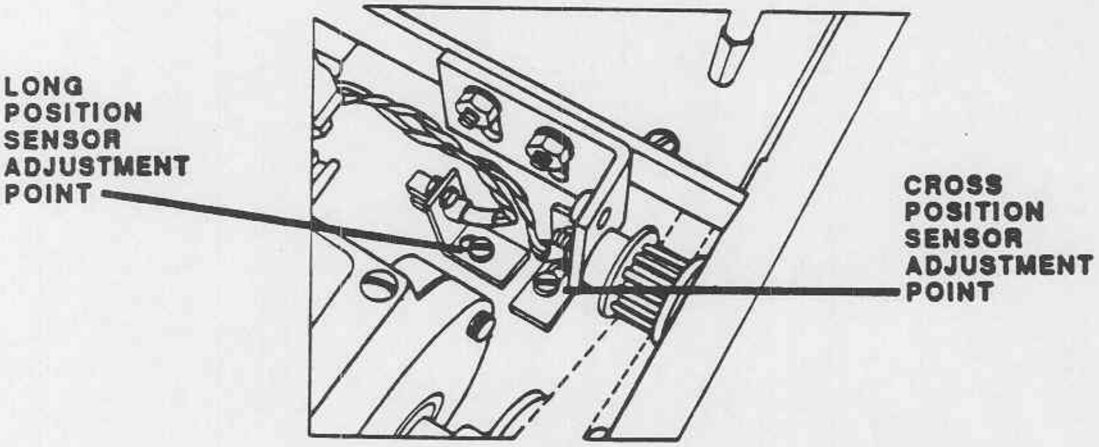
*CROSS and LONG, as used here, refer to X-ray table directions.
**Refer to Section 7.6, *Establishing Home Position of Cassette Carriage*, for details.


SENSITIVITY ADJUST
INDICATOR LED

CASSETTE PRESENT SENSOR DETAIL
Figure 7.5


LOAD POSITION SENSOR ADJUSTMENT POINT

LOAD POSITION SENSOR DETAIL
Figure 7.6

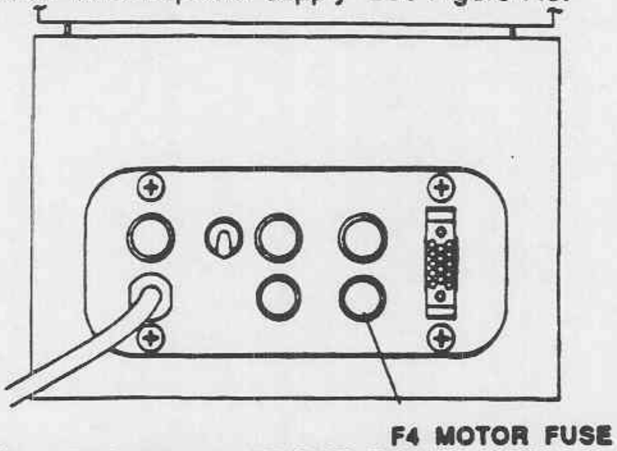

LONG POSITION SENSOR ADJUSTMENT POINT
CROSS POSITION SENSOR ADJUSTMENT POINT

PARK POSITION SENSORS DETAIL
Figure 7.7

7.6 ESTABLISHING HOME POSITION OF CASSETTE CARRIAGE

The **HOME** position is similar to **PARK**, but is only achieved when the cassette carriage is fully retracted into the rear left-hand corner of the chassis, as would be the case with a 4-on-1 format selection. This position is extremely important, for it serves as a reference point from which the cassette carriage proceeds. If the reference point shifts from the factory setting as a result of major mechanical repairs or replacement, for example, the entire procedure below must be done. Rarely will this be necessary, however, and the procedure can be used for less extensive repairs, such as a bent sensor bracket.

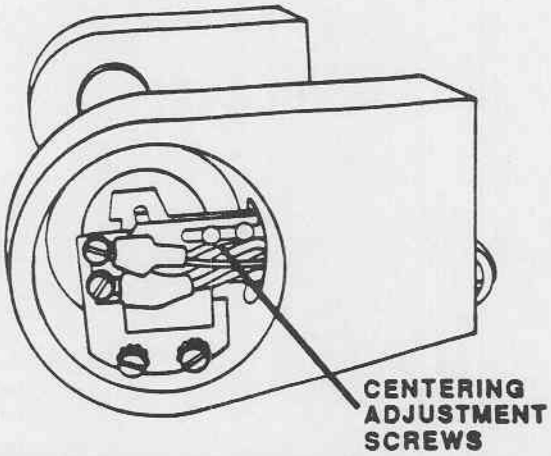
1. Remove F4 motor fuse on power supply See Figure 7.8.



POWER SUPPLY FRONT PANEL (F4)
Figure 7.8

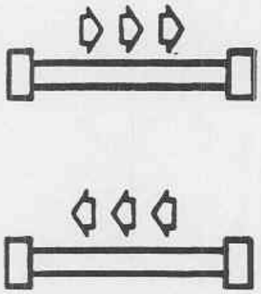
2. Be sure **PARK** and **CROSS** Position Sensors are both out of the contact area.
3. Power on, and manually move cassette holder to center and rear of unit until front - outside edge of cassette holder is perfectly in line with rear edge of Exposure opening of main frame.
4. Press **RESET** button on main CPU board.
5. Carefully move **PARK** Position Sensor towards rear edge of main slide plate until audible lock-in of relays is heard. Lock sensor down carefully at that exact position.
6. Locate and securely fasten bumper stop flush with rear edge of main slide plate.
7. Manually move cassette holder toward left side of main slide plate until left-outside edge of cassette holder is even with left-outside edge of main slide plate.
8. Press **RESET** button on CPU board.
9. Carefully move **CROSS** Position Sensor towards flag attached to cassette holder until audible lock-in of relays is heard. Lock sensor down carefully at that exact position. **HOME** position has now been established at this point.
10. Power-off and re-insert F4 motor fuse on power supply.
11. Power-on, and proceed to check for proper cassette (holder) location on all formats.

7.7 ADJUSTMENT OF HANDLE SENSORS



SIDE MOVEMENT HANDLE SENSOR DETAIL
Figure 7.9

Figure 7.9 shows the right-hand portion of the Power-Assist Handle when the end plug has been removed. Two opto-interrupters are located in the recess. These respond to sideward movement. They have been factory-adjusted for optimum sensitivity consistent with tactile "feel" and should suit a large number of users. If less sensitivity is desired, or if a switch is replaced, they can be adjusted. The degree of handle movement between left and right is controlled by the centering of the right-angled "flag" in the slots of the opto-interrupters. Obviously, at rest, the flag should be equidistant from each switch half. To adjust, loosen the phillips head screws securing the slotted area of the flag, slide the flag and retighten. Figure 7.10 below shows the relay contact connection points on the Interface Board headers for ohmmeter checks:

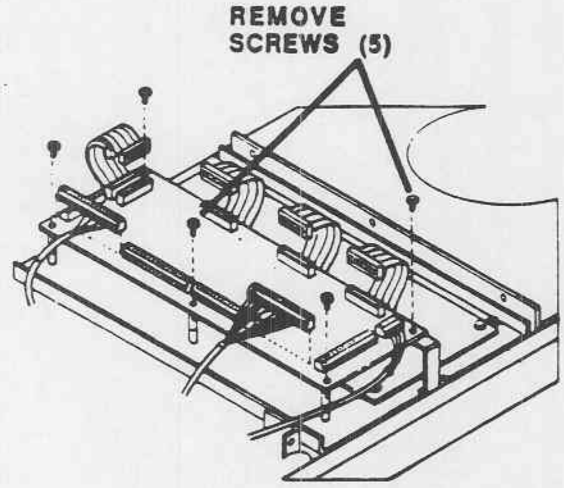


Function	Terminals	Relay Closed	Reading
Tower right (foot)	J9-2, J9-3	K17	Low Res.
Tower left (head)	J9-1, J9-3	K12	Low Res.

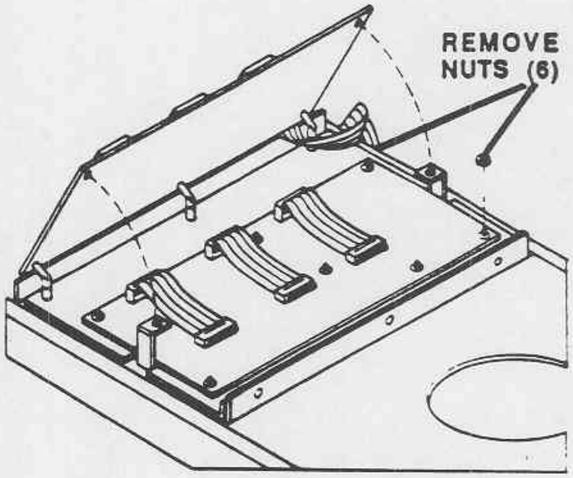
POWER ASSIST HANDLE ADJUSTMENT
Figure 7.10

7.8 INTERFACE CIRCUIT BOARD REMOVAL AND REPLACEMENT (See Figure 7.11)

1. Turn **OFF** power to the SFD.
2. Remove the rear cover, following the instructions in paragraph 7.2, above.
3. Disconnect all ribbon cable connectors and headers from the circuit board. Individual wires, including those in harnesses, are wired to the headers. It may be necessary to use a pocket screwdriver or similar tool to pry the ends of the headers away from the circuit board. Alternate from end to end to avoid bending the pins. DO NOT use any more force than absolutely necessary.
4. Remove the five screws, three in the rear and two in front, securing the board. Lift out the board. Reassembly is a reversal of the above procedure.



INTERFACE CIRCUIT BOARD REMOVAL
Figure 7.11



CPU CIRCUIT BOARD REMOVAL
Figure 7.12

7.9 CPU CIRCUIT BOARD REMOVAL AND REPLACEMENT

CAUTION: *Special precautions are necessary when handling static-sensitive components such as the CPU and peripheral devices. Irreparable damage can be caused by touching an input lead, especially when done in a low humidity environment. The following points should be followed to minimize the possibilities of damage:*

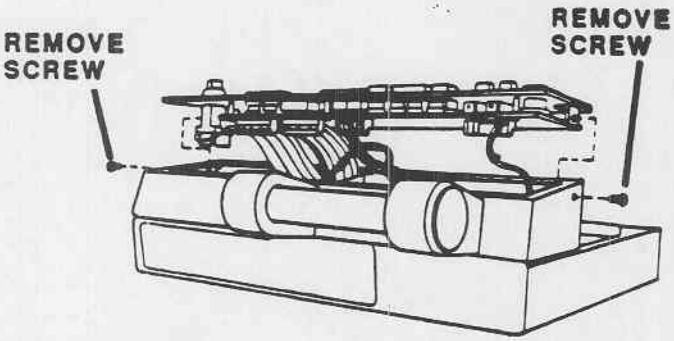
- *All AC test equipment used, in addition to surrounding electrical apparatus, should be grounded in accordance with National Electrical Code Standards, as well as local codes.*
- *All work surfaces should be covered with copper or aluminum and grounded by use of a strap or braid to a solid earth ground.*

- *All personnel working on the equipment should be grounded to the work surface by means of a metallic wrist strap in series with a one megohm resistor.*

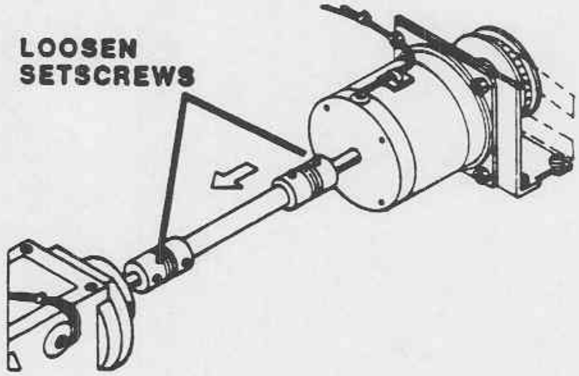
1. Turn **OFF** power to the SFD.
2. Remove the rear cover, following the instructions in paragraph 7.2, above.
3. Remove the two screws in the front of the Interface Board.
4. Disconnect ribbon connectors P11 and P12. Hinge back the Interface Board (see Figure 7.12), then disconnect P1, P2 and P3 where they plug into the CPU Board. Observe the same precautions as for removing the connectors on the Interface Board.
5. Remove the six 1/4 inch nuts securing the circuit board to the chassis. Lift out the board. Reassembly is a reversal of the above procedure.

7.10 FRONT PANEL CIRCUIT BOARD REMOVAL AND REPLACEMENT (See Figure 7.13)

1. Turn **OFF** power to the SFD.
2. Remove the two screws on each side of the SFD near the front.
3. Remove the decorative knobs from the collimator shutter slide controls.
4. Lift the rear of the Front Panel Assembly approximately 1/2 inch (13 mm), while sliding it to the rear. Lift out the assembly.
5. Disconnect all ribbon cables and headers. Observe the same precautions as for removing the connectors on the Interface and CPU Boards.
6. Remove the ten screws holding the board in place. Lift out the circuit board. Reassembly is a reversal of the above procedure.



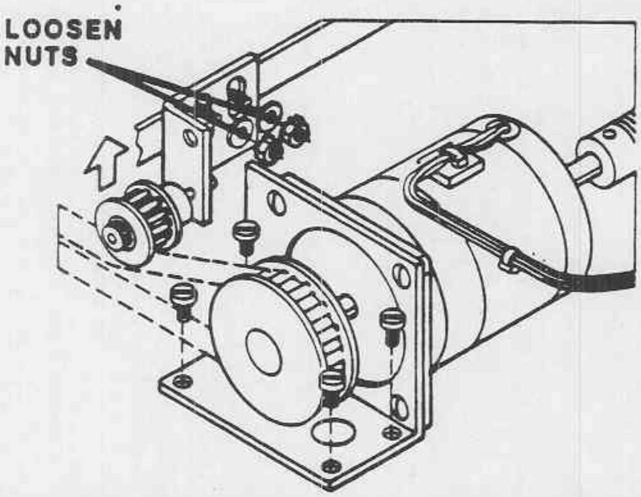
FRONT PANEL CIRCUIT BOARD REMOVAL
Figure 7.13



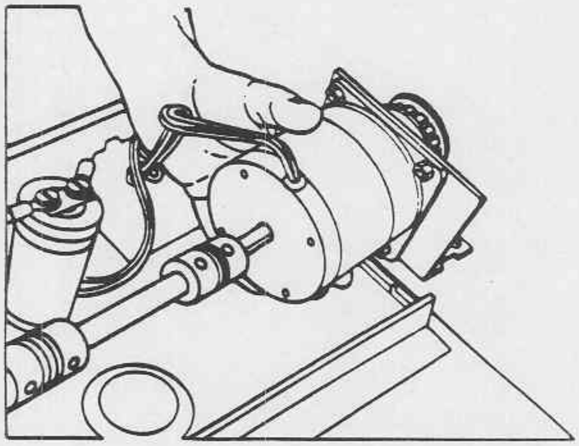
DRIVE SHAFT DECOUPLING
Figure 7.14

7.11 STEPPER MOTOR REPLACEMENT

1. Turn **OFF** power to the SFD.
2. Remove the rear cover, following the instructions in paragraph 7.2, above.
3. The Stepper Motor wiring is connected to the Stepper Motor Driver (the black anodized unit in the corner) by means of a header. Cut the cable tie securing the harness and remove the motor wires from the header (black - term. 1, orange - term. 2, yellow - term. 3 and red - term. 4).
4. Manually rotate the shaft linking the Stepper Motor to the Clutch/Brake Assembly until the setscrews on the couplings are visible.
5. Loosen the setscrews on the motor and Clutch/Brake sides of the shaft to allow axial movement, then slide the shaft toward the clutch/brake so that the output shaft of the motor is disengaged from the coupling. See Figure 7.14.



SIDE-TO-SIDE TENSIONING ADJUSTMENT
Figure 7.15



MOTOR REPLACEMENT
Figure 7.16

6. Loosen the tensioning pulley above the motor assembly. See Figure 7.15.
7. Remove the four motor bracket screws, then disengage the pulley from the cogged belt.

CAUTION: *When handling the belt, never force it or pry it over a pulley flange. To slide a belt in or out of position, remove the pulley.*

8. Carefully lift out the motor by angling slightly for clearance. See Figure 7.16.
9. Note that the pulley is installed on the shaft extending from the mounting side of the motor. Remove the pulley and save it for installation on the replacement motor shaft. Note that the motor shaft has a flat. Be sure that the setscrew is resting on the flat before tightening.
10. Install the new motor, following the procedure in reverse.

11. Re-tension the belt so that it does not deflect more than 3/8 inch (9 mm).

12. Tighten the tensioning pulley. See Figure 7.15.

13. Reconnect the motor wiring to the header. Refer to Step 3 for connection points versus color coding. Secure the harness with a new cable tie.

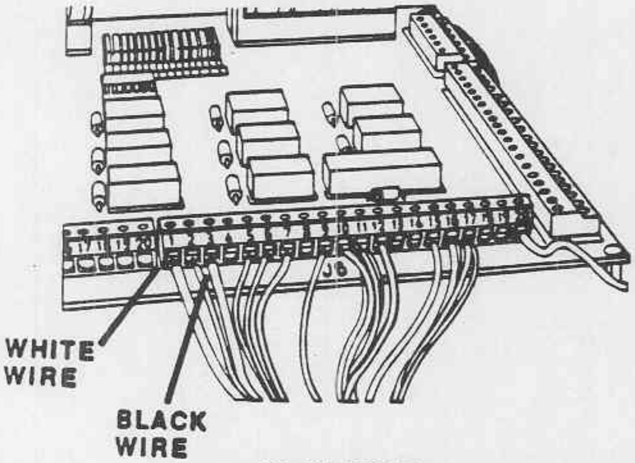
7.12 CLUTCH/BRAKE ASSEMBLY REPLACEMENT

1. Turn **OFF** power to the SFD.

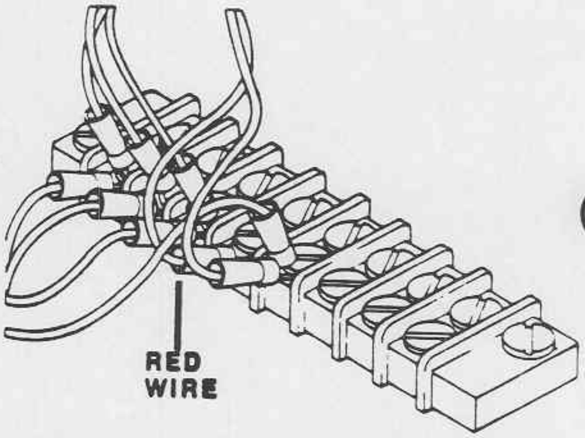
2. Remove the rear cover, following the instructions in paragraph 7.2, above.

3. The Clutch/Brake wiring is connected both to a header that is mounted to the Interface Board and to the AC input terminal block in the rear corner of the SFD chassis. Carefully cut the cable ties that secure the wiring.

4. Remove the white wire from terminal 1 of header J6; the black wire from terminal 3. See Figure 7.17. Remove the red wire from terminal 4 of the AC input terminal block. See Figure 7.18.



J6 WIRING
Figure 7.17

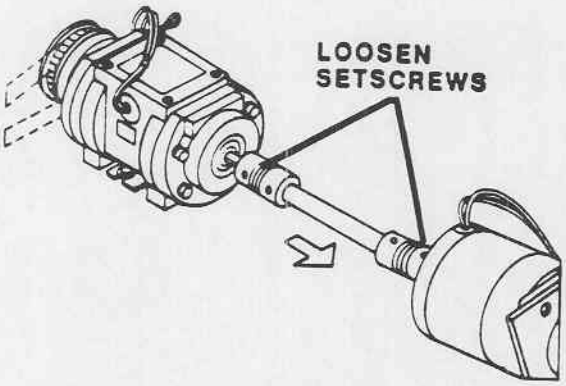


AC INPUT TERMINAL BLOCK DETAIL
Figure 7.18

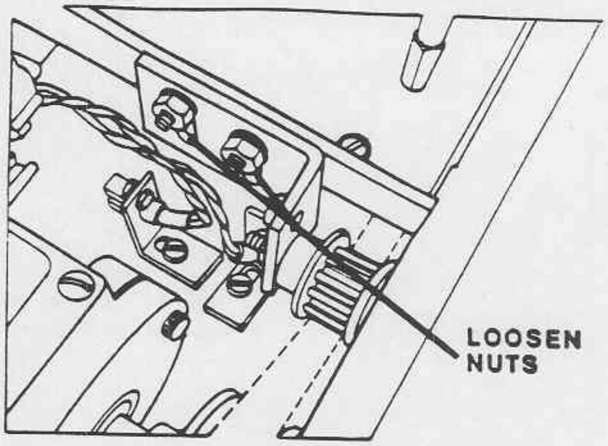
5. Manually rotate the shaft linking the stepper motor to the Clutch/Brake Assembly until the setscrews on the couplings are visible.

6. Loosen the setscrews on the motor and clutch/brake sides of the shaft to allow axial movement, then slide the shaft toward the motor so that the input shaft of the Clutch/Brake is disengaged from the coupling. See Figure 7.19.

7. Loosen the tensioning pulley above the Clutch/Brake Assembly. See Figure 7.20.



CLUTCH/BRAKE REPLACEMENT
Figure 7.19



BELT TENSIONING ADJUSTMENT
Figure 7.20

8. Remove the four screws that secure the Clutch/Brake Assembly to the chassis.

9. Disengage the pulley from the cogged belt and lift out the assembly. Observe the caution note in the previous section.

10. Note that the pulley is installed on the shaft extending from the OUTPUT side of the assembly. Remove the pulley and save it for installation on the replacement Clutch/Brake output shaft. When re-installing, tighten one setscrew into the keyway to help prevent loosening.

11. Install the new Clutch/Brake Assembly following the procedure in reverse.

12. Re-tension the belt so that it does not deflect more than 3/8 inch (9 mm).

13. Tighten the tensioning pulley.

14. Reconnect the wiring to the header and terminal block. Refer to Step 4 for connection points versus color coding. Secure the harness(es) with (a) new cable tie(s).

7.13 BELT REPLACEMENT

The two drive belts are constructed of a high reliability fiberglass/neoprene/nylon composite and should last throughout the life of the unit. To assure smooth operation and to prevent premature failure, belts being stored should be protected against sharp bending or creasing. They should never be subjected to extremely high or low temperatures, high humidity, or high ozone concentrations while being stored. If a belt must be replaced, follow the procedure below:

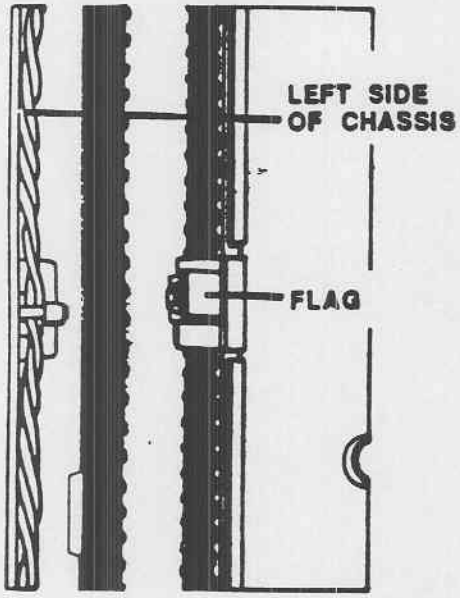
NOTE: The belt that is driven from the clutch/brake (on the observers' left when facing the front) is referred to as the "front-to-back" belt; the belt that is driven directly by the motor is the "side-to-side" belt.

7.13.1 FRONT-TO-BACK BELT REPLACEMENT

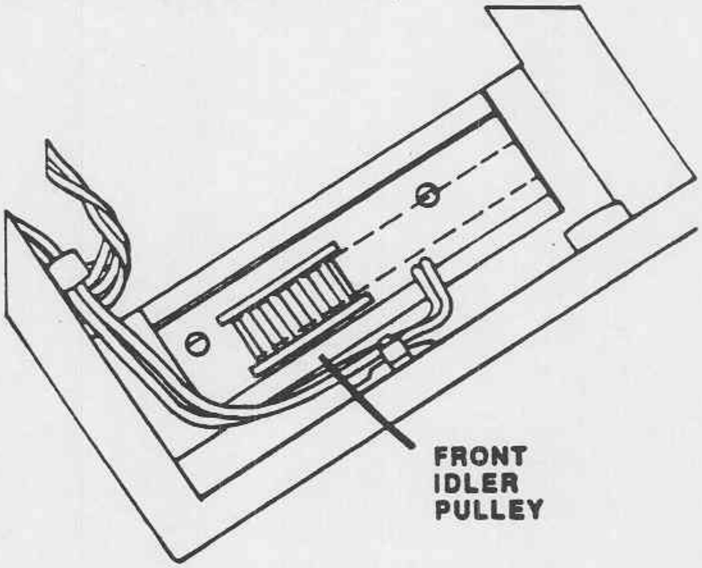
1. Turn **OFF** power to the SFD.
2. Remove the imaging system following the instructions provided by the manufacturer.
3. Remove the rear cover, following the instructions in paragraph 7.2 above.
4. Remove the front cover, following the instructions in paragraph 7.3 above.
5. Remove the imaging system adapter plate by removing the eight screws securing it to the SFD and lifting it from the chassis. See Figure 7.3.
6. Loosen the tensioning pulley above the Clutch/Brake Assembly.
7. Disconnect the flag on the carriage from the belt. See Figure 7.21.
8. If necessary, remove the four screws securing the Clutch/Brake to the chassis.
9. Remove the worn or broken belt and install the replacement belt. (Reassembly is a reversal of the above procedure.)

> **WARNING!**
> **BE SURE TO FASTEN THE IMAGING SYSTEM ADAPTER PLATE SECURELY. USE LOCTITE™ #232 ON THE SCREW THREADS AFTER THOROUGHLY CLEANING OFF ANY OIL OR GREASE.**

10. Be sure to retension the drive belt (3/8 inch [9 mm] deflection).



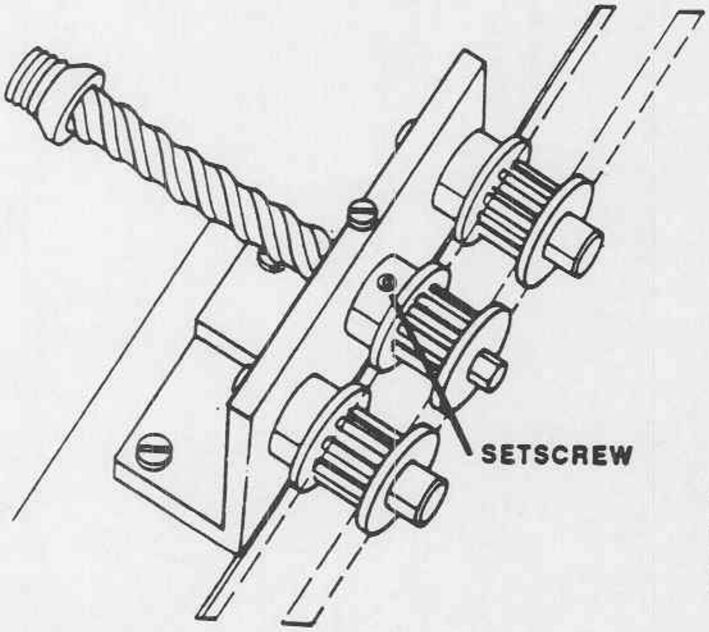
CARRIAGE TO BELT DISASSEMBLY
Figure 7.21



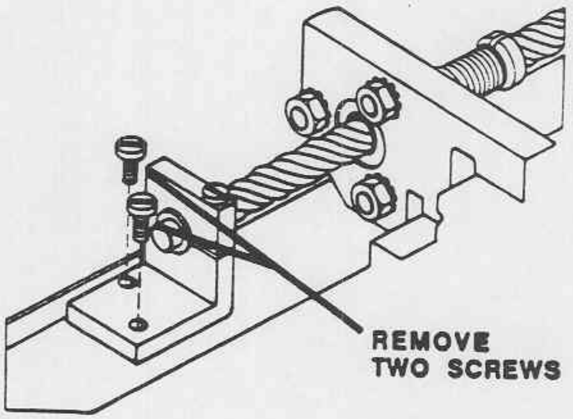
FRONT IDLER PULLEY DETAIL
Figure 7.22

7.13.2 SIDE-TO-SIDE BELT REPLACEMENT

1. Perform Steps 1-5 as detailed in the procedure for replacing the front-to-back belt.
2. Perform Steps 1-4 as detailed in the procedure for removing the front panel.
3. Loosen the tensioning pulley above the motor assembly.
4. Locate the front idler pulley in the access hole below the right-hand side of the front panel. To determine the point of belt removal see Figure 7.22.
5. Rotate the leadscrew so that the setscrew in the pulley is accessible. See Figure 7.23.
6. Remove the two screws securing the leadscrew mounting bracket to the chassis. See Figure 7.24.



LEADSCREW PULLEY SETSCREW DETAIL
Figure 7.23



LEADSCREW MOUNTING BRACKET REMOVAL
Figure 7.24

7. While supporting the pulley from below, pull the leadscrew free by moving it away from the pulley.
8. If necessary, remove the Stepper Motor Assembly.
9. Remove the worn or broken belt and install the replacement belt. Carefully form a loop with the leadscrew pulley and reattach the leadscrew bracket before hooking the belt over the front idler. Hook the belt over the motor pulley last. Reassembly is a reversal of the above procedure. Remember to retension the belt.

NO TEXT

SECTION 8.0

THEORY OF OPERATION

8.0 THEORY OF OPERATION

8.1 MECHANICAL OPERATION

This device uses one DC stepper motor to provide front-to-back and side-to-side motion. Coupled with an electromagnetic clutch/brake and leadscrew drive, this patented design makes use of the principle of differential friction. This motor has an output shaft at each end, therefore, equal torque is transmitted to the clutch/brake and to the side-to-side belt (the one with the leadscrew carriage drive).

When the brake is deactuated (clutch engaged) a low friction path exists from the motor to the front-to-back belt, and since the carriage is bolted directly to the belt, it moves in response to the motor. At the same time, the fixed friction presented by the three pulleys plus the leadnut on the other side (side-to-side belt) prevents sideward movement of the cassette carriage. (The leadscrew and pulleys then move as a unit with the belt.)

Conversely, when the brake is actuated (clutch disengaged), the friction presented exceeds the friction of the three pulleys and leadnut. Torque is then transmitted to the side-to-side belt.

8.2 INTRODUCTION TO ELECTRONIC THEORY

This section describes the electronic circuitry. Most of this solid-state circuitry is mounted on three printed circuit boards; the CPU Board, the Spotfilm Interface Board, and the Front Panel Board.

The CPU Board contains the Central Processing Unit (CPU), memory, and I/O (input/output) ports.

Interfacing to the X-ray system and SFD electromechanical components is provided by the Interface Circuit Board. All signals to and from the CPU and system are buffered as they pass through this circuit board.

Operating controls are mounted on the Front Panel Board, directly behind the front panel. Most of these controls are lighted pushbutton switches. However, two slide controls for manual control of the collimator shutters and a two-position, center-off rotary switch are also present. The rotary switch activates the table tilting mechanism.

An LED Display is also located on the Front Panel Board. This display provides the operator with a visual indication of the arrangement and number of unexposed frames remaining in the selected spotfilm format. It also provides error displays if the cassette carriage is empty, the cassette is "full", or the SFD is not locked in its forward position.

SFD operating voltages are produced by a separate power supply. This power supply is installed in a location that meets the user's requirements.

The circuit description in this section begins with an overview of operation based on a functional block diagram. Then, the circuitry on each board is described separately. The schematic diagrams, including that of the power supply, are located in Section 10 of this manual.

8.3 BLOCK DIAGRAM DISCUSSION

Figure 8-1 is the functional block diagram of the SFD electronic circuitry. As the figure shows, this microprocessor-based circuitry consists of a CPU (Central Processing Unit), memory, interfacing circuits, I/O ports, interfaces, and support circuits. An 8-bit address bus and 8-bit bi-directional data bus link the CPU to memory and peripherals. An 8-bit I/O (input/output) bus is also used for the transfer of data to and from the front panel, cassette carriage, and other peripherals.

Circuit operation is under the control of the CPU, U1. The CPU is an 8-bit microprocessor that processes and transfers 8-bit data over the data bus and 8-bit addresses over the address bus.

The CPU directs SFD operation by executing a program that is permanently stored in Program Storage Memory, U6. As the CPU executes the program, it generates variables and stores them in System RAM (Random Access Memory), U8.

Most of the signals that pass through U17 before being applied to the I/O bus are data to other X-ray system components. However, some signals, such as data used by Motor Controller/Driver U36 to effect cassette carriage positioning, control SFD functions.

Front Panel, locks, and other SFD functional data pass through the Interface Circuit Board to U28 from the I/O bus. Data from the Front Panel, Cone, and Grid also pass over the I/O bus and through U28.

The cassette carriage also sends data to the CPU through U28. This data notifies the CPU of the cassette carriage's position; Home, Park/Lock, or some intermediate position, as determined by spotfilm format and the frame being exposed. Position data is generated by Hall Effect devices mounted on the chassis and flag-mounted magnets on the cassette carriage.

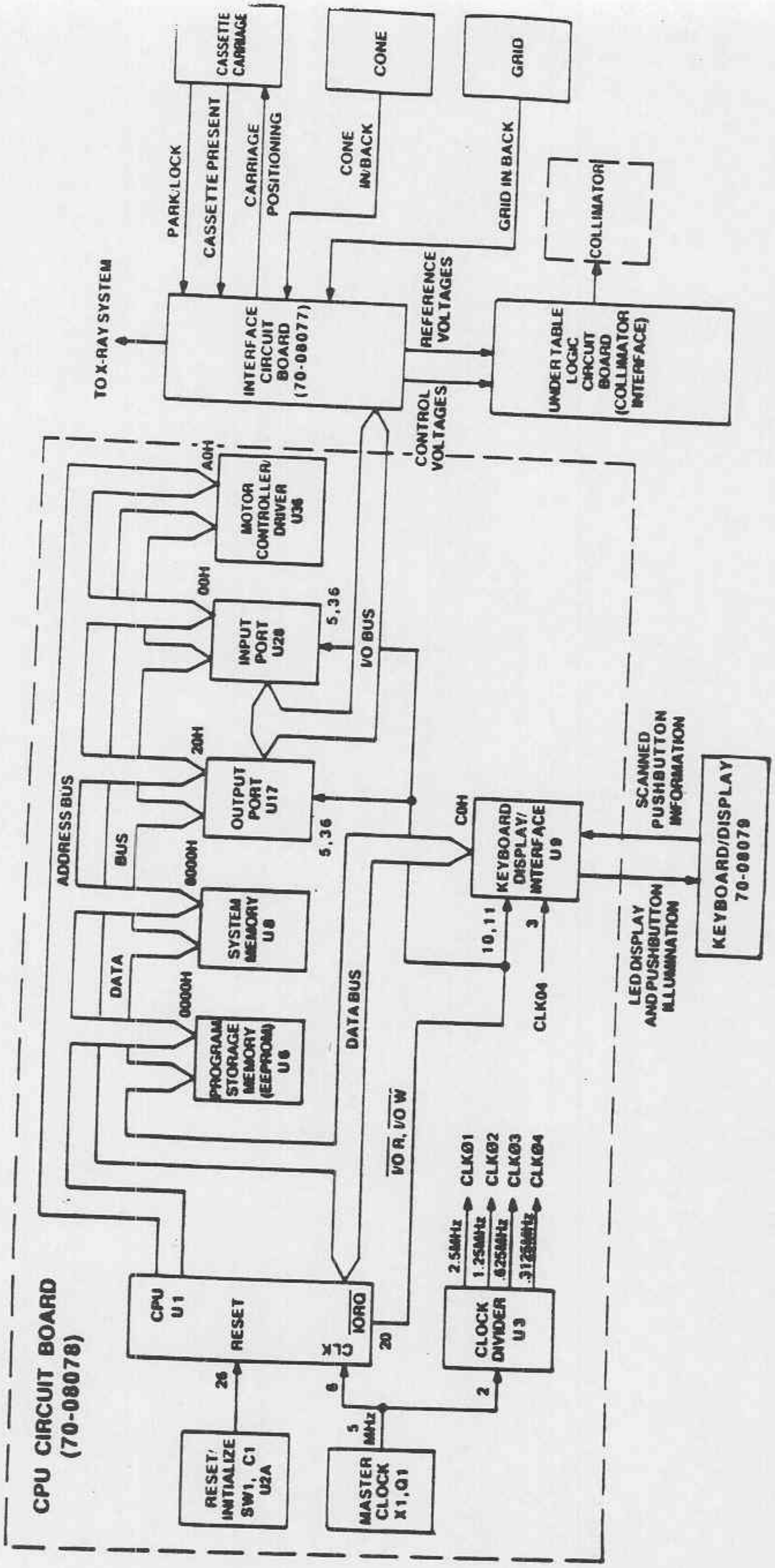
The Front Panel applies inputs to the SFD and other system components when the operator actuates a control. Most of these controls are pushbutton switches arranged in a matrix that is decoded by U9. LED Display data also passes through U9.

CPU operation is directly supported by the Reset/Initialize and Master Clock circuits. The Reset/Initialize circuit, SW1, C1, U2A and associated components ensure that the CPU is directed to the proper memory address when power is applied or when the system is manually reset.

Timing signals for the CPU are supplied by the Master Clock, consisting of X1, Q1, and associated circuitry. This circuit drives the CPU CLK (clock) input and the Clock Divider. As its name implies, the Clock Divider divides the 5 MHz (Megahertz) Master Clock output into several lower-frequency timing signals for the Keyboard Encoder/Interface and other SFD circuits.

8.4 CIRCUIT DESCRIPTION

This subparagraph describes the operation of the circuitry in the SFD. See the appropriate schematic diagram as needed while reading this description. Schematic diagrams are in Section 10 of this manual.


CASSETTE CARRIAGE
CONE
GRID
PARK/LOCK
CASSETTE PRESENT
CARRIAGE POSITIONING
CONE IN/BACK
GRID IN BACK
COLLIMATOR
TO X-RAY SYSTEM
INTERFACE CIRCUIT BOARD (70-08077)
REFERENCE VOLTAGES
UNDERTABLE LOGIC CIRCUIT BOARD (COLLIMATOR INTERFACE)
CONTROL VOLTAGES
A0H
MOTOR CONTROLLER/ DRIVER U36
00H
INPUT PORT U28
5,36
I/O BUS
20H
OUTPUT PORT U17
5,36
ADDRESS BUS
BUS
8000H
SYSTEM MEMORY U8
DATA
0000H
PROGRAM STORAGE MEMORY (EEPROM) U6
DATA BUS
C0H
KEYBOARD DISPLAY/ INTERFACE U9
SCANNED PUSHBUTTON INFORMATION
KEYBOARD/DISPLAY 70-08079
LED DISPLAY AND PUSHBUTTON ILLUMINATION
10,11
3
CLK04
I/O R, I/O W
2.5MHz
1.25MHz
.625MHz
.3125MHz
CLK01
CLK02
CLK03
CLK04
CPU U1
RESET
CLK
IORQ
20
26
6
5 MHz
2
CLOCK DIVIDER U3
RESET/ INITIALIZE SW1, C1 U2A
MASTER CLOCK X1,Q1
CPU CIRCUIT BOARD (70-08078)

SYSTEM BLOCK DIAGRAM
Figure 8.1

8.4.1 CPU BOARD (70-08078)

All SFD logic circuitry is located on the CPU Board. This circuitry consists of the CPU (Central Processing Unit), system memory, keyboard encoder, address encoders and decoders, the programmable timer, Reset/Initialize, and Master Clock circuits.

When power is first applied to the SFD, or immediately after MANUAL RESET switch SW1, at the left rear corner of the CPU Board, is momentarily pressed, the voltage across C1 is zero volts. The voltage is applied as a low (logic 0) to pin 1 of inverter U2A (U2A-1). This high output from U2A-2 is then sent to U2B-3 and inverted again before being applied as a low to the CPU RESET input, U1-26, forcing the CPU to its reset state.

After power is applied, or when SW1 is released, C1 begins charging and the voltage on U2A-1 increases toward +5 volts. Approximately 220 mS (milliseconds) later, the voltage at U2A-1 reaches 3 volts. This voltage is high enough to enable inverter U2A with the result that U2A-2 drives U2B-3 low. This causes U2B-4 to go high (logic 1) and drive U1-26 high, completing the CPU 220 mS initialize/reset cycle.

Q1, X1, and associated components form a 5 MHz oscillator that serves as the Master Clock circuit for the SFD. The 5 MHZ square wave output from this circuit is inverted by U2C and applied to the CPU's CLK (clock) input at U1-6.

A sample of the inverted and buffered oscillator output is also sent to Clock Divider U3. This circuit consists of four frequency dividers that convert the 5 MHz input to 0.3125 MHz (CLK4), 0.625 MHz (CLK3), 1.25 MHz (CLK2), and 2.5 MHz (CLK1).

The CPU, U1, is an 8-bit microprocessor that accepts commands from the front panel in the form of encoded pushbutton closures. The CPU then decodes these commands and directs SFD operation by executing the appropriate program instructions.

The program, or software, that the CPU executes is permanently stored as firmware in U6. Only about 2K (kilobytes) of this 128K EPROM (Erasable Programmable Read-Only Memory) is used for firmware storage.

CPU architecture is such that the first program instruction must be located at memory address 0000_H (Hexadecimal). As a result, U6's addressing also begins at 0000_H.

The CPU cannot change the contents of U6. However, during program execution, the CPU generates variables that must be stored for later use. Therefore, RAM (Random Access Memory), U8, is used as System Memory starting at address 8000_H for the storage of these dynamic variables.

Three I/O ports, U17, U28, and U36 are used in the SFD circuitry; U17 acts as an output port while U28 serves as an input port. U36 is part of the circuitry that generates drive pulses for the cassette carriage stepper motor.

Output port U17, located at port address 20_H, enables the CPU to use the I/O bus to send data to devices outside of the CPU board. This includes control data for lights in the control switches on the front panel, the X-ray generator, positioning of the SFD cassette carriage, and other system functions. Each output data bit is buffered by an inverter.

When the CPU applies port address 00_H to the address bus, input data can be applied to the data bus from outside the CPU Board. U28 accepts inputs from the SFD cassette carriage, grid, and cone and applies them to the data bus. All signals from outside the circuit board are applied through opto-isolators to prevent their voltage levels from damaging U28.

The CPU uses Motor Controller/Driver U36 to produce the timing signals used by the CPU to generate drive pulses for the stepping motor that positions the cassette carriage. U36 is a programmable timer that is programmed during SFD initialization.

When the execution of program instructions requires repositioning of the cassette carriage, the CPU periodically accesses U36 at port address A0H. At the same time, programming causes U17-10 to go low. This low is applied to U39-9 and -10. U39-8 then goes low and drives U36-11 low.

After a timed interval, U36-13 goes low and causes U39-6 to go high. This high, in conjunction with the high at U39-8, causes U39-11 to produce a negative-going pulse. The negative-going pulse is then sent to the CPU. The CPU then executes programming for generating cassette carriage motor drive pulses.

The timed interval is determined by CLK0, CLK1, and CLK2. Since each of these timing pulses occurs at a different frequency, the interval between the low-going output pulses from U39-11 also varies. These pulses are then sent to U1-26, causing the CPU to execute program instructions for generating stepper motor drive pulses and applying them to the data bus.

Both memory and port addressing are used in the SFD. Memory addressing is used for storing and retrieving program data while I/O data passes through ports. Therefore, like memory, each I/O port has its own address.

When the program instructs the CPU to write (transfer data) to memory, U1-5 (A15) goes high and U1-19 (MREQ) and -22 go low while the desired address is applied to the address bus. This high at U1-5 is applied directly to pin 1 of NAND-gate U4A. At the same time, the low on U1-19 is applied to U2E-11. U2E then produces a high and sends it to U4A-2. This high, along with the one at U4A-1 causes U4A-3 to go low before being sent to U8-18 and -20.

Simultaneously, the lows at U1-19 and -22 are also applied to U7A-1 and -2, respectively. This low is fed to U8-21, enabling U8 to store the data on the data bus at the address on the address bus.

Transferring data from (read) U8 is similar. The main difference is that U7A-3 does not drive U8-21 low.

As mentioned earlier, the CPU cannot change the contents of U6. However, it can read its contents without destroying them. The CPU does this by applying highs from U1-15 and U1-19 to U2D-9 and U2E-11, respectively, while applying the memory address to the address bus. Both highs are inverted and sent to U4B-4 and -5. U4B's output, at pin 6, is then coupled to U6-22 and -20. The contents of the memory location on the address bus are then read over the data bus.

The addressing of ports is similar to that of addressing memory. While each port has an address that is distinct from the others, the addresses are not necessarily distinct from memory. For example, the address of output port U17 is 20_H. However, there is also a memory location at this address. Therefore, the CPU uses the I/O Address Decoder, U5 for port addressing.

Whenever the CPU has data for the output port, U17, it is applied to the data bus while the port address (20_H) is sent to U5-3, -2, and -1. At the same time, U1-20 (IORQ) and U2F-13 go low. After inversion by U2F, the signal is applied as a high to U5-6, enabling U5 to address the port by sending a low to U1-6 (CS - chip select).

After the CPU has addressed the port, it writes data by driving U1-22 and -20 low. These lows are then sent to U7B-4 and -5, respectively, enabling U7B to produce I/O WR (I/O write) at pin 6. This low causes the port to accept the data on the bus.

Reading data from input port U28 is a similar process. Its address (00_H) is applied to U5 and U1-20 goes low. U5 applies a low to U28-6 and U7C produces the I/O RD (I/O read) signal to enable the CPU to read data from the port. This includes the cassette carriage positioning data produced by sensors on the carriage and chassis, respectively.

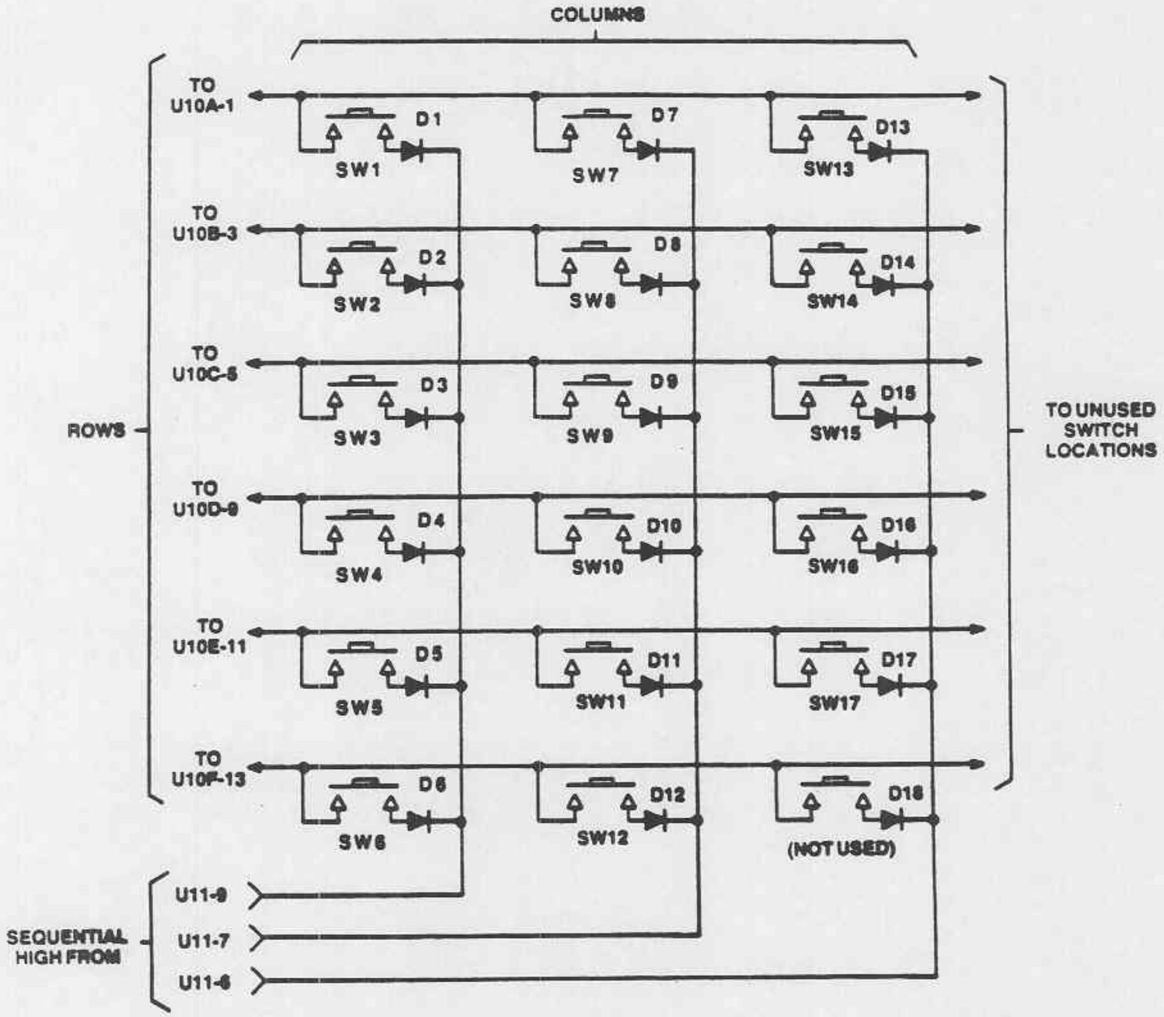
Control data enters the SFD by means of pushbutton switches on the front panel. As the simplified schematic diagram in Figure 8-2 shows, these pushbutton switches are arranged in a matrix similar to that of a keyboard. U9 scans this matrix by sequentially applying binary coded decimal (BCD) values from U9-32, -33, and -34 to U11-13, -14, and -15, respectively. U11 then produces sequential highs on U11-9, -7, and -6 and applies them to the matrix columns (U11-5, -4, -3, and -2 are not used). If a pushbutton is pressed, the associated row goes high. Each column is connected to an inverter, U10A-1, U10B-3, U10C-5, U10D-9, U10E-11, or U10F-13. This high drives the output of the appropriate inverter low.

The low from the inverter is then fed to U9-38, -39, -1, -2, -5, or -6 as row data. Since U9 already "knows" which of U11's output (column) lines are high, it can identify the pressed switch because only one is present at the intersection of any given row and column. U11 then generates the appropriate data and sends it to the CPU over the data bus when U9-10 goes low. When the CPU receives keyboard data from U9, it executes the program instructions necessary to execute the SFD or system function that the pressed pushbutton selects.

As the CPU executes program instructions, it generates data for display on the Front Panel. This data is sent to U9 over the data bus and the CPU drives U9-11 low. U9 then applies the data (pins 23-30) through buffer amplifiers and opto-isolators to the front panel.

8.4.2 INTERFACE BOARD (70-08077)

All SFD and system I/O signals, except for Front Panel data, pass through the Interface Board. Cassette (carriage) positioning, mode selection, and lock signals are just a few examples.


COLUMNS
TO U10A-1
TO U10B-3
TO U10C-5
TO U10D-9
TO U10E-11
TO U10F-13
ROWS
D1
SW1
D7
SW7
D13
SW13
D2
SW2
D8
SW8
D14
SW14
D3
SW3
D9
SW9
D15
SW15
D4
SW4
D10
SW10
D16
SW16
D5
SW5
D11
SW11
D17
SW17
D6
SW6
D12
SW12
D18
(NOT USED)
TO UNUSED SWITCH LOCATIONS
SEQUENTIAL HIGH FROM
U11-9
U11-7
U11-6

SIMPLIFIED SCHEMATIC - KEYBOARD INTERFACE
Figure 8.2

In most cases, I/O signals (data) energize relays that apply operating voltages to the device(s) they control. These relays act as buffers to protect the electronic circuitry from the voltages and currents used to power the cassette carriage, longitudinal power assist, table locks, table tilt mechanism, etc.

While microprocessor-controlled circuitry minimizes interfacing requirements, some calibration is needed to ensure that the collimator's characteristics match those of the SFD. The circuitry for this calibration is also located on this circuit board.

Collimator calibration circuitry consists of eight controls in parallel across an isolated 12 VDC reference voltage from the collimator. Each control is adjusted to prevent the collimator shutter blades from "fluttering" (alternately opening and closing) when they are set to minimum aperture by R1 and R2 for the selected function. R1 and R2 are the manual collimator controls on the Front Panel. For example, R14 is adjusted to prevent shutter blade fluttering when the one-on-two spotfilm format is selected.

8.4.3 KEYBOARD/DISPLAY BOARD (70-08079)

Except for the Power Assist Handle, all SFD operating controls and indicators are located on the Front Panel Board. Most of these controls are illuminated pushbutton switches arranged in a keyboard matrix whose operation has already been described.

However, the functions controlled by some of the pushbuttons do not need to be processed by the CPU and, therefore, these switches are not part of the matrix. These include 2-way table top motion, which is controlled by SW18 and SW19. Prep request (PREPARE), SW11B, directs the generator to prepare the X-ray tube for an exposure. Control of compression (vertical) and carriage locks is also exercised without the use of the CPU by SW23 and SW24, respectively.

Two slide controls, R1 and R2, are included on the Front Panel as part of the collimator shutter control circuit. These controls enable operators to manually vary the aperture size of the undertable collimator in any SFD mode of operation.

Even though R1 and R2 have continuous control over the aperture size of the undertable collimator in all modes, the range of this control varies. In the fluoro (Fluoroscopic) mode, these controls can change aperture size from full minimum to full maximum (full minimum and full maximum are determined by collimator characteristics, calibration, and source-to-image distance).

However, in the radiographic mode, maximum aperture size is also affected by the spotfilm format (split) in use. For example, maximum aperture size for one-on-one is much larger than for nine-on-one. Therefore, R1 and R2 cannot increase aperture size beyond the maximum for the split in use at a given SID.

The front-panel LED Display provides operators with a visual indication of SFD status. The CPU uses a 5 X 5 section of the 7 X 5 LED (light emitting diode) matrix to display the number of unexposed frames remaining on a cassette. It also displays error messages when all frames on the cassette have been exposed or if it is improperly positioned.

Even though individual LEDs and their matrix arrangement are not shown in the schematic diagram, operation of the LED Display is similar to that of the keyboard. The Keyboard/Encoder Interface, U9, on the CPU Board applies row data, consisting of various concurrent combinations of logic 1's (highs) and 0's (lows), to the LED Display through row driver transistors Q1, Q2, Q3, Q4, and Q5; one bit to each transistor. Those driver transistors having logic 1 applied are enabled, but those having logic 0's are not.

Similarly, combinations of Q11, Q12, Q13, Q14, and Q15 are enabled by column data from U9. This, in conjunction with the enabled row drivers, causes the LED(s) at the intersection(s) of the enabled row(s) and column(s) to light.

Note that the Keyboard/Encoder Interface does NOT scan the LED Display, making it possible for more than one LED to be lit at a time, as is often required. Furthermore, whenever an exposure is made or a cassette positioning error occurs, the CPU updates the data and the LED display changes accordingly.

8.4.4 POWER SUPPLY (70-10416)

The SFD Power Supply is a separate unit that uses switching (digital) circuitry to produce the operating voltages required by the SFD. It produces four output voltages; 115 VAC, 79 VDC, 28 VAC, and 24 VDC. As the schematic diagram shows, these voltages are produced by three independent circuits. Input power is fused to protect both the power supply and SFD against excessive current.

Closing SW1 lights the PWR-ON indicator and simultaneously applies power to the circuitry for all output voltages. A sample of this voltage is fed through F3 to terminal A on the output connector where it is available as grounded 115 VAC.

Input power is also applied to dual-secondary step-down transformer T1. One of its secondaries applies 28 VAC to a network that steps up and rectifies the voltage. The full wave output from this circuit is applied through slow-blow fuse F4 as 79 VDC to terminal H of the output connector.

The remaining secondary of T1 applies unfused 28 VAC directly to output terminal H.

A third sample of the 115 VAC input voltage is sent to the network that converts it to 24 VDC. The output of this network is fused by F2 and applied to output terminal R.

SECTION 9.0

RENEWAL PARTS LIST

FOR **EXT-950**™ SPOT FILM DEVICE

RENEWAL PARTS LIST

Note: The items listed below are the most commonly requested items. For Eureka part numbers for items not listed here, refer to the parts lists in Section 10.

Eureka P/N	Description
70-20127-2	Cable, Power Supply, 30 ft.
70-08021	Cable, Density, Interconnecting
77-30000	Apron, Lead
77-20001	Assembly, Power supply
70-08297	Supply, Power, HC-24
70-06011	Transformer, 56-8
70-04574	Lamp
70-04266	Switch, Toggle, 15 Ampere
70-03033	Rectifier, Bridge
70-04611	Fuse, Fast, 1 Amp, 250 V
70-04604	Fuse, 10 Amp 32 V
70-04612-1	Fuse, Slo-Blow, 3 amp 250 V
70-04612-2	Fuse, Slo-Blow, 7 amp 250 V
70-06535	Cord, Line, 3 Conductor, 8 ft.
70-06103	Driver, Stepper Motor
70-10448	Pulley, Timing
70-10376	Latch, Trip, Holder
70-04643	Plate, Striker
70-10445	Pulley, Timing Belt, 1/5 Pitch
70-10483	Bracket, Bumper
70-10423	Slide, Ball Bearing, 28 inch
70-04642	Stop, Bumper
70-04274	Clutch/Brake
70-10451	Coupling, Flexible
70-10425	Motor, Stepper
70-10446	Pulley, Timing Belt

EXT-950™

RENEWAL PARTS LIST (Continued)

Note: The items listed below are the most commonly requested items. For Eureka part numbers for items not listed here, refer to the parts lists in Section 10.

Eureka P/N	Description
70-03012	Rectifier, 1 amp, 100 V
70-02520	Capacitor, Electrolytic, 2400 uF, 100 VDC
70-10347	Cover, Rear
70-10487	Knob, Rotary (DENSITY) optional
70-08079	Keyboard PCB Assembly
70-04268	Lamp, Incandescent
70-04270	Block, Switch Contact
70-10478	Knob, Black
70-04243	Switch, Rotary, 1 Amp
70-20158	Power Assist Handle
70-04699	Hole Cover, Snap-in
70-10484	Belt
70-10449	Belt, Timing, 69" long
70-08078	Z80 CPU Board
70-08077	Interface Board
70-10447	Pulley, Timing, 10XL 037-DF
70-10448	Pulley, Timing, 12XL 037-DF
70-10424	Slide, Cassette Holder, Two-Member
70-20162	2:1 Mask Assembly
70-20161	Compression Cone Assembly
70-10452	Plunger, Spring Loaded
77-50000	Ion Chamber Assembly
77-6000	Grid

SECTION 10.0

BILLS OF MATERIAL
AND
SCHEMATICS

NO TEXT

BILL OF MATERIALS
POWER SUPPLY ASSEMBLY
70-10416

Item No.	Ref. Design	Part No.	Description	Vendor Part No.
1		70-10468	Chassis	
2		70-08297	Power Supply	HC24
3		70-06011	Transformer	56-8
4		70-04621	Fuseholder	
5		70-04574	Lamp	
6		70-04266	Switch, Toggle, 15 AMP	
7		70-04651	Relief Strain (Heyco)	SR -6N3-4
8		70-10409	Plate, Mounting	
9		70-03033	Bridge, Rectifier	10R250JBZL
10		70-04554	Block, Socket	
11		70-04555	Pin, Socket	
12	F3	70-04611	Fuse, Fastact 1 AMP, 250 V	
13	F1	70-04604	Fuse, 10 AMP, 32V	
14	F4	70-04612-2	Fuse, Slo-Blo, 7 AMP, 250V	
15	F2	70-04612-1	Fuse, Slo-Blo, 3 AMP, 250V	
16		24-10061	Cord, Stator, 3 Conductor	
17		70-04630	Terminal - Ring #10 - Blue	
18		70-04629	Ring Terminal #8 - Red	
19		26-02223	Washer, #8 Steel	
20		70-06507	Wire, 16 GA/105°C ORG. Insulated	
21		70-06515	Wire, Blue, 18 GA/80°C PVC Insulated	
22		70-06508	Wire, 16 GA/105°C Yel. Insulated	
23		70-06538	Org. Hook-up Wire, 18 AWG	
24		70-06506	Wire 16 GA/105°C Blue Insulated	
25		70-06516	Wire 18 GA/105°C WHT Insulated	
26		70-06542	Wire Green Hook-up, 18 AWG	
27		70-06518	Wire, Hook-up WHT, 22 AWG	
28		70-06537	Wire, Hook-up ORG, 22 AWG	
29		70-06605	Tubing, Shrink, 1/4" BLK	
30		70-06604	Tubing, Shrink, 3/16" BLK	
31		70-10986	Nut, Steel KEPS - 8-32 UNC-2B	
32		70-10905	Screw, 4-40X1/4 Slot Pan HD	
33		26-00406	Screw, 8-32 Slot Pan HD	
34		26-00789	Screw 10-24X1/2 PH RDH	
35		26-00247	10-24 KEP HEX Nut	
36		26-02253	#8X.50 OD FW ZP	
37		70-04568	Guide Pin-Male	
38		70-04569	Guide Pin-Female	
39		70-04575	Spring, Locking	
40		70-10408	Plate, Mounting	
41		00-02-1325	Nameplate	
42		70-10805	Rivet, Blind	
43		70-06524	Jumper, Bus Bar, 24 AWG	

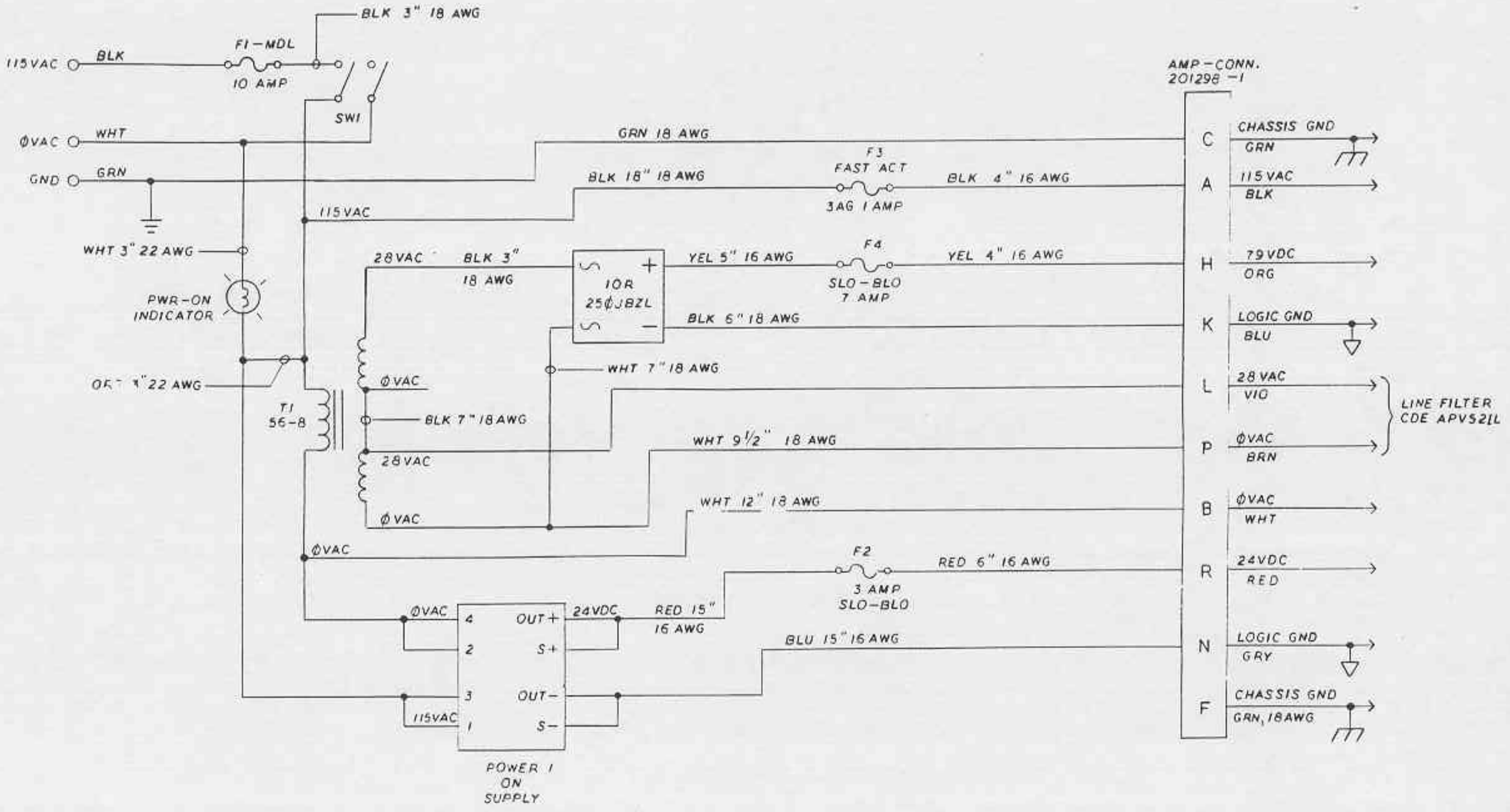
EXT-950 POWER SUPPLY
70-10416
Table 10.1

NO TEXT

HC 28-2-4-A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED



BLK 3" 18 AWG
115VAC
BLK
F1 - MDL
10 AMP
SW1
ØVAC
WHT
GND
GRN
GRN 18 AWG
BLK 18" 18 AWG
F3
FAST ACT
3AG 1 AMP
BLK 4" 16 AWG
115VAC
WHT 3" 22 AWG
PWR-ON INDICATOR
ORG 3" 22 AWG
28VAC
BLK 3" 18 AWG
10R 25ØJBZL
YEL 5" 16 AWG
F4
SLO-BLO 7 AMP
YEL 4" 16 AWG
BLK 6" 18 AWG
WHT 7" 18 AWG
ØVAC
T1 56-8
BLK 7" 18AWG
28VAC
WHT 9½" 18 AWG
ØVAC
WHT 12" 18 AWG
ØVAC
F2
3 AMP SLO-BLO
RED 6" 16 AWG
ØVAC
4
OUT+
24VDC
RED 15" 16 AWG
2
S+
BLU 15" 16 AWG
3
OUT-
115VAC
1
S-
POWER 1 ON SUPPLY
AMP-CONN. 201298-1
C
CHASSIS GND
GRN
A
115VAC
BLK
H
79VDC
ORG
K
LOGIC GND
BLU
L
28VAC
VIO
LINE FILTER CDE APV52IL
P
ØVAC
BRN
B
ØVAC
WHT
R
24VDC
RED
N
LOGIC GND
GRY
F
CHASSIS GND
GRN, 18AWG

DWG. NO. 70-10416 SH 1 REV A

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APPROVALS	DATE
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ISSUED	

EUREKA X-RAY TUBE CO.

POWER SUPPLY SCHEMATIC

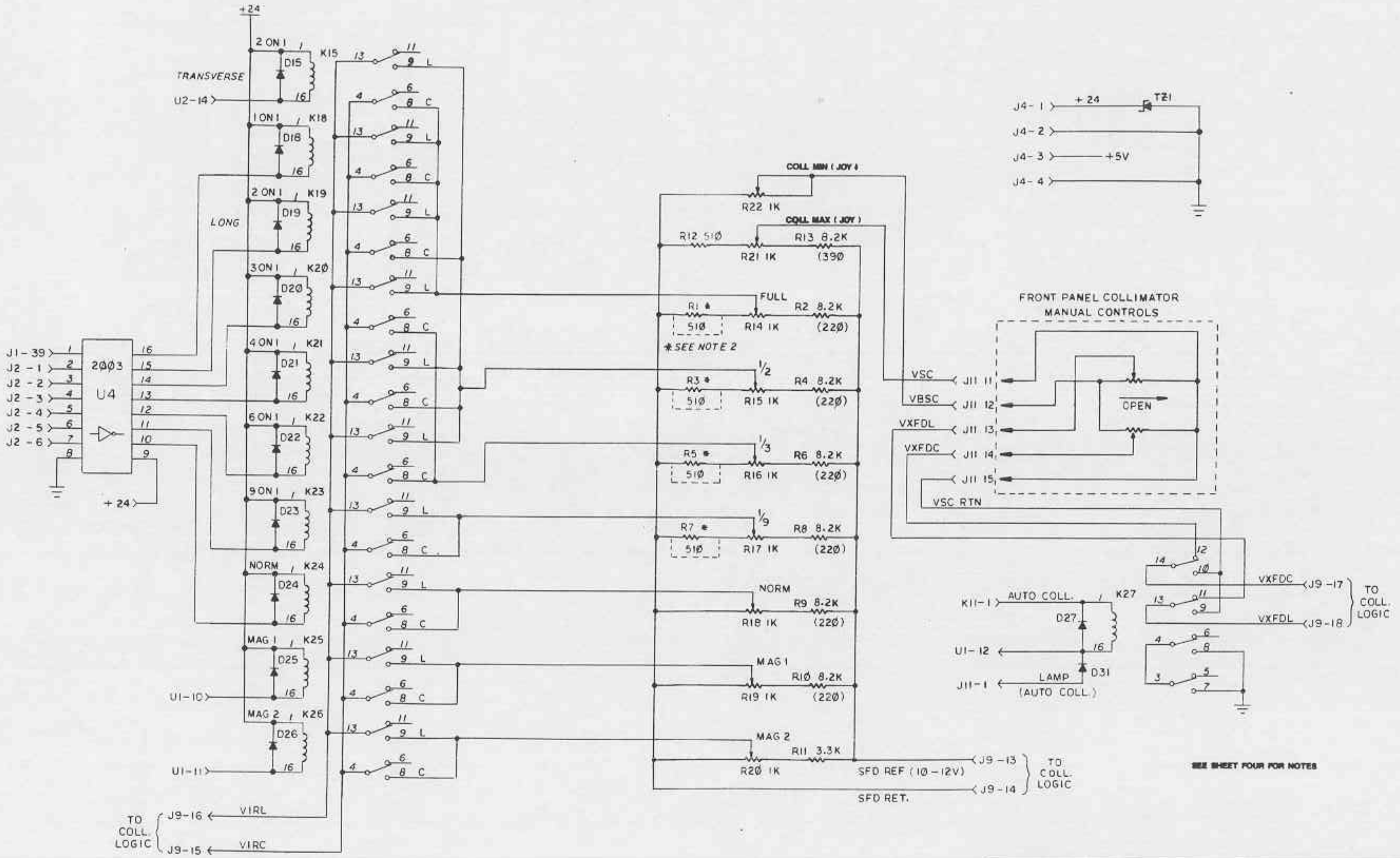
Figure 10.1
Page 10-5

SIZE C
ITEM CLASS
DWG. NO. 70-10416
REV. A
SCALE
SHEET 1 OF 1

BILL OF MATERIALS
EXT Z80 INTERFACE PCB ASSEMBLY
70-08077

Item No.	Ref. Design	Part No.	Description	Vendor Part No.
1		70-06281	EXT Z80 Interface P.C.B.	
2	U1-4	70-03146	I.C. 16 Pin DIP	ULN2003
3	D1-4, 7-15, 16-30	70-03012	Diode	IN4002
4	TZ-1	70-03075	Diode, Transzorb	15KE39
5	R2, 4, 6, 8 9, 10	70-00026	Resistor, 220Ω, 1/4W, ±5%	
6	R1, 3, 5, 7	70-06524	Wire, 22 AWG, Solid	
7	R12	70-00032	Resistor, 390Ω, 1/4W, ±5%	
8	R11	70-00052	Resistor, 3.3KΩ, 1/4W, ±5%	
9	R23-42	70-00035	Resistor, 510Ω, 1/4W, ±5%	
10	R14-22	70-00653-2	Resistor, Var. 25T, 1K, Bourns	3299W
11	K1-4, 15-26 28, 7-9	70-04018	Relay, 24 VDC, Omron	G6A-234P-ST-U5
12	K10, 11, 27	70-04019	Relay, 24 VDC, Omron	G6A-434P-ST-U5
13	J1-3	70-04527	Header, 40 Pin	821-A040P-AFA00
14	J11, 12	70-04526	Header, 34 Pin	821-A034P-AFA00
15	J4-10	70-04528	Pin Strips (Electrovert)	Z5-584-2125
16		21-20260	SR900 Silicone Resin Solution	
17	R13	70-00027	Resistor, Carbon Film, 240Ω, 1/4W, 5%	
18	RP1	70-00510	Resistor Array, 10KΩ, 10 Pin SIP	
19	U5	70-03203	Current Sink Driver	ULN2596A

EXT Z80 INTERFACE PCB ASSEMBLY
70-08077
Table 10.2


+24
2 ON 1
K15
D15
TRANSVERSE
U2-14
1 ON 1
K18
D18
2 ON 1
K19
D19
LONG
3 ON 1
K20
D20
4 ON 1
K21
D21
6 ON 1
K22
D22
9 ON 1
K23
D23
NORM
K24
D24
MAG 1
K25
D25
U1-10
MAG 2
K26
D26
U1-11
J1-39
J2-1
J2-2
J2-3
J2-4
J2-5
J2-6
2003
U4
+24
13
11
9
L
4
6
8
C
16
TO COLL. LOGIC
J9-16
VIRL
J9-15
VIRC
COLL MIN (JOY)
R22 1K
COLL MAX (JOY)
R12 510
R13 8.2K
R21 1K
(390)
FULL
R1 *
510
R14 1K
R2 8.2K
(220)
* SEE NOTE 2
1/2
R3 *
510
R15 1K
R4 8.2K
(220)
1/3
R5 *
510
R16 1K
R6 8.2K
(220)
1/9
R7 *
510
R17 1K
R8 8.2K
(220)
NORM
R9 8.2K
R18 1K
(220)
MAG 1
R10 8.2K
R19 1K
(220)
MAG 2
R11 3.3K
R20 1K
J9-13
SFD REF (10-12V)
J9-14
SFD RET.
TO COLL. LOGIC
J4-1
+24
TZ1
J4-2
J4-3
+5V
J4-4
FRONT PANEL COLLIMATOR MANUAL CONTROLS
VSC
J11 11
VBSC
J11 12
VXFDL
J11 13
VXFDC
J11 14
J11 15
OPEN
VSC RTN
K11-1
AUTO COLL.
K27
D27
U1-12
D31
J11-1
LAMP (AUTO COLL.)
14
12
10
13
11
9
4
6
8
3
5
7
VXFDC
J9-17
VXFDL
J9-18
TO COLL. LOGIC
SEE SHEET FOUR FOR NOTES

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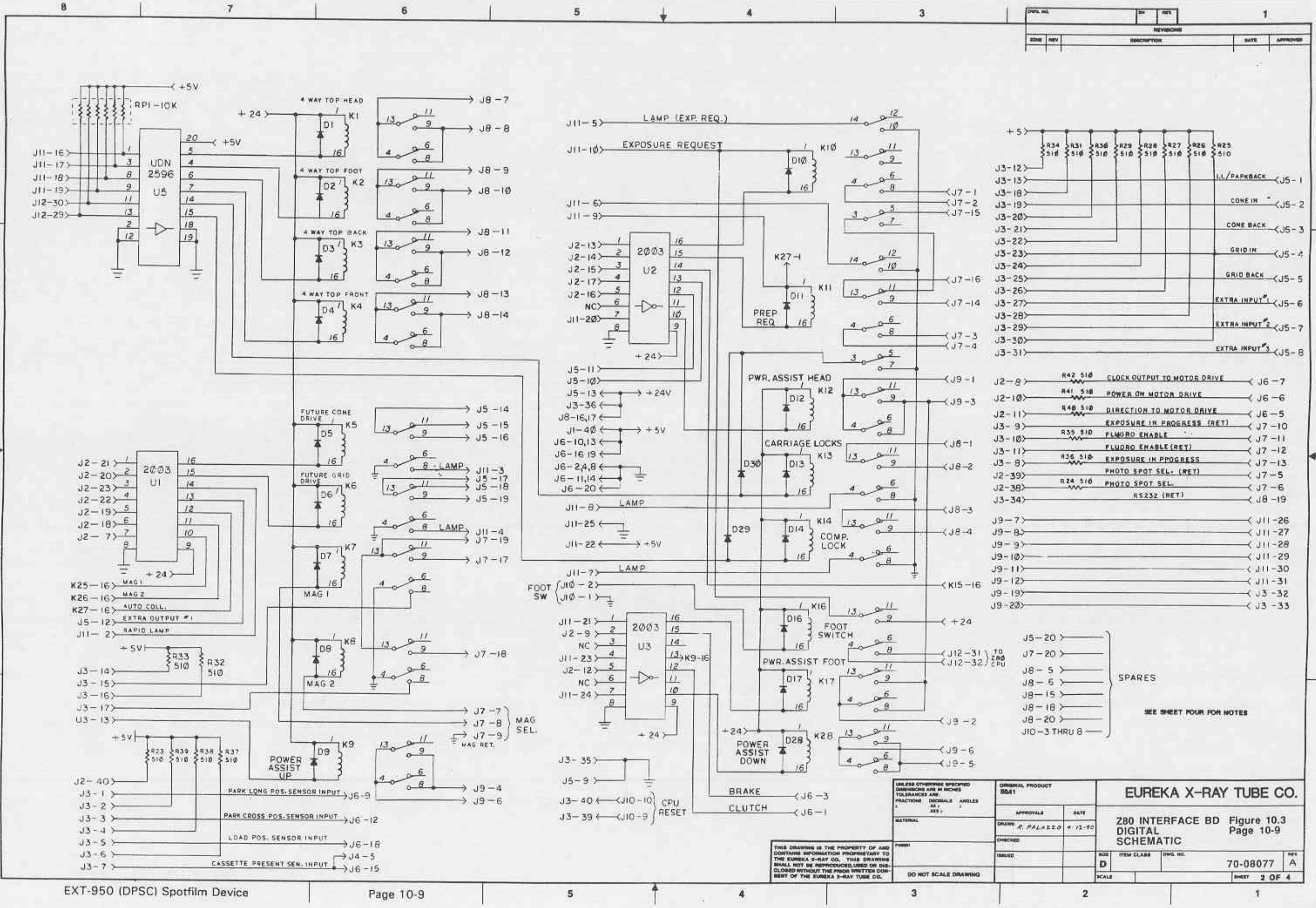
EUREKA X-RAY TUBE CO.

Z80 INTERFACE BD
ANALOG
SCHEMATIC

Figure 10.2
Page 10-8

SIZE D
ITEM CLASS
DWG. NO. 70-08077
REV. A
SCALE
SHEET 1 OF 4


RPI-10K
+5V
UDN 2596 U5
J11-16
J11-17
J11-18
J11-19
J12-30
J12-29
+24
4 WAY TOP HEAD
K1
D1
J8-7
J8-8
4 WAY TOP FOOT
K2
D2
J8-9
J8-10
4 WAY TOP BACK
K3
D3
J8-11
J8-12
4 WAY TOP FRONT
K4
D4
J8-13
J8-14
FUTURE CONE DRIVE
K5
D5
J5-14
J5-15
J5-16
FUTURE GRID DRIVE
K6
D6
LAMP
J11-3
J5-17
J5-18
J5-19
K7
D7
MAG I
J11-4
J7-19
J7-17
K8
D8
MAG 2
J7-18
J7-7
J7-8
J7-9
MAG SEL.
MAG RET.
K9
D9
POWER ASSIST UP
J9-4
J9-6
2003 U1
J2-21
J2-20
J2-23
J2-22
J2-19
J2-18
J2-7
K25-16
K26-16
K27-16
J5-12
J11-2
MAG 1
MAG 2
AUTO COLL.
EXTRA OUTPUT #1
RAPID LAMP
R33 510
R32 510
J3-14
J3-15
J3-16
J3-17
U3-13
R23 510
R39 510
R38 510
R37 510
J2-40
J3-1
J3-2
J3-3
J3-4
J3-5
J3-6
J3-7
PARK LONG POS. SENSOR INPUT
J6-9
PARK CROSS POS. SENSOR INPUT
J6-12
LOAD POS. SENSOR INPUT
J6-18
CASSETTE PRESENT SEN. INPUT
J4-5
J6-15
J11-5
LAMP (EXP. REQ.)
J11-10
EXPOSURE REQUEST
K10
D10
J11-6
J11-9
J7-1
J7-2
J7-15
2003 U2
J2-13
J2-14
J2-15
J2-17
J2-16
NC
J11-20
K27-1
K11
D11
PREP REQ
J7-16
J7-14
J7-3
J7-4
J5-11
J5-10
J5-13
+24V
J3-36
J8-16,17
J1-40
J6-10,13
J6-16 19
J6-2,4,8
J6-11,14
J6-20
J11-8
J11-25
J11-22
PWR. ASSIST HEAD
K12
D12
J9-1
J9-3
CARRIAGE LOCKS
K13
D13
D30
J8-1
J8-2
K14
D14
D29
COMP. LOCK
J8-3
J8-4
J11-7
FOOT SW
J10-2
J10-1
K15-16
2003 U3
J11-21
J2-9
J11-23
J2-12
J11-24
K9-16
K16
D16
FOOT SWITCH
+24
J12-31
J12-32
TO Z80 CPU
PWR. ASSIST FOOT
K17
D17
J9-2
K28
D28
POWER ASSIST DOWN
J9-6
J9-5
J3-35
J5-9
J3-40
J10-10
J3-39
J10-9
CPU RESET
BRAKE
J6-3
CLUTCH
J6-1
R34 510
R31 510
R30 510
R29 510
R28 510
R27 510
R26 510
R25 510
J3-12
J3-13
J3-18
J3-19
J3-20
J3-21
J3-22
J3-23
J3-24
J3-25
J3-26
J3-27
J3-28
J3-29
J3-30
J3-31
I.I./PARKBACK
J5-1
CONE IN
J5-2
CONE BACK
J5-3
GRID IN
J5-4
GRID BACK
J5-5
EXTRA INPUT #1
J5-6
EXTRA INPUT #2
J5-7
EXTRA INPUT #3
J5-8
J2-8
R42 510
CLOCK OUTPUT TO MOTOR DRIVE
J6-7
J2-10
R41 510
POWER ON MOTOR DRIVE
J6-6
J2-11
R40 510
DIRECTION TO MOTOR DRIVE
J6-5
J3-9
EXPOSURE IN PROGRESS (RET)
J7-10
J3-10
R35 510
FLUORO ENABLE
J7-11
J3-11
FLUORO ENABLE (RET)
J7-12
J3-8
R36 510
EXPOSURE IN PROGRESS
J7-13
J2-39
PHOTO SPOT SEL. (RET)
J7-5
J2-38
R24 510
PHOTO SPOT SEL.
J7-6
J3-34
RS232 (RET)
J8-19
J9-7
J11-26
J9-8
J11-27
J9-9
J11-28
J9-10
J11-29
J9-11
J11-30
J9-12
J11-31
J9-19
J3-32
J9-20
J3-33
J5-20
J7-20
J8-5
J8-6
J8-15
J8-18
J8-20
J10-3 THRU 8
SPARES
SEE SHEET FOUR FOR NOTES
DWG. NO.
SH
REV.
REVISIONS
ZONE
REV.
DESCRIPTION
DATE
APPROVED
8
7
6
5
4
3
2
1
D
C
B
A

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MATERIAL

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ORIGINAL PRODUCT 5041

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EUREKA X-RAY TUBE CO.

Z80 INTERFACE BD
DIGITAL
SCHEMATIC

Figure 10.3
Page 10-9

SIZE	ITEM CLASS	DWG. NO.	REV
D		70-08077	A

SCALE
SHEET 2 OF 4

Z80CPU	INTERFACE BD.		INTERFACE BD.	FRONT PANEL	
J1-01	J1-01		J12-01	J1-01	< RL0
J1-02	J1-02		J12-02	J1-02	< RL1
J1-03	J1-03		J12-03	J1-03	< RL2
J1-04	J1-04		J12-04	J1-04	< RL3
J1-05	J1-05		J12-05	J1-05	< RL4
J1-06	J1-06		J12-06	J1-06	< RL5
J1-07	J1-07	•			
J1-08	J1-08	•			
J1-09	J1-09		J12-12	J1-12	> S5
J1-10	J1-10		J12-11	J1-11	> S4
J1-11	J1-11		J12-10	J1-10	> S3
J1-12	J1-12		J12-09	J1-09	> S2
J1-13	J1-13		J12-08	J1-08	> S1
J1-14	J1-14		J12-07	J1-07	> S0
J1-15	J1-15		J12-13	J1-13	> DS0
J1-16	J1-16		J12-14	J1-14	> DS1
J1-17	J1-17		J12-15	J1-15	> DS2
J1-18	J1-18		J12-16	J1-16	> DS3
J1-19	J1-19		J12-17	J1-17	> DS4
J1-20	J1-20		J12-18	J1-18	> DS5
J1-21	J1-21		J12-19	J1-19	> DS6
J1-22	J1-22		J12-20	J1-20	> DS7
J1-23	J1-23		J12-21	J1-21	> DS8
J1-24	J1-24	•			
J1-25	J1-25	•			
J1-26	J1-26	•			
J1-27	J1-27	•			
J1-28	J1-28	•			
J1-29	J1-29	•			
J1-30	J1-30	•			
J1-31	J1-31		J12-22	J1-22	> SEG A
J1-32	J1-32		J12-23	J1-23	> SEG B
J1-33	J1-33		J12-24	J1-24	> SEG C
J1-34	J1-34		J12-25	J1-25	> SEG D
J1-35	J1-35		J12-26	J1-26	> SEG E
J1-36	J1-36		J12-27	J1-27	> SEG F
J1-37	J1-37		J12-28	J1-28	> SEG G
J1-38	J1-38	•	J12-29	J1-29	> COMP LOCKS
J1-39	J1-39	> 1 ON 1	J12-30	J1-30	> CARRIGE LOCKS
J1-40	J1-40	< + 5 VDC	J12-31	J1-31	< FOOT SWITCH (KEYBD. EXP)
			J12-32	J1-32	< FOOT SWITCH (KEYBD. EXP)
			J12-33	J1-33	•
			J12-34	J1-34	•

INTERFACE BD.	
J4-01	< + 24 VDC
J4-02	< 24 VDC RTN
J4-03	< + 5 VDC
J4-04	< 5 VDC RTN
J4-05	< CASS PRES

INTERFACE BD.	
J5-01	< PARK BACK SWITCH
J5-02	< CONE IN
J5-03	< CONE BACK
J5-04	< GRID IN
J5-05	< GRID BACK
J5-06	< EXTRA INPUT #1
J5-07	< EXTRA INPUT #2
J5-08	< EXTRA INPUT #3
J5-09	> GRND
J5-10	> PHOTO SPOT SELECT
J5-11	> PHOTO SPOT PREP
J5-12	> EXTRA OUTPUT #1
J5-13	> + 24 VDC
J5-14	> CONE DRIVE COMMON
J5-15	> CONE DRIVE N.C.
J5-16	> CONE DRIVE N.O.
J5-17	> GRID DRIVE COMMON
J5-18	> GRID DRIVE N.C.
J5-19	> GRID DRIVE N.O.
J5-20	•

INTERFACE BD.	
J6-01	> CLUTCH
J6-02	> CLUTCH RTN
J6-03	> BRAKE
J6-04	> BRAKE RTN
J6-05	> DIRECTION-MOTOR
J6-06	> POWER -MOTOR
J6-07	> CLOCK PULSES
J6-08	> CLOCK PULSES RTN
J6-09	> PARK POSITION LONG
J6-10	> + 5 VDC
J6-11	> GRND
J6-12	> PARK POSITION CROSS
J6-13	> + 5 VDC
J6-14	> GRND
J6-15	> CASSETTE PRESENT
J6-16	> + 5 VDC
J6-17	> GRND
J6-18	> LOAD POSITION
J6-19	> + 5 VDC
J6-20	> GRND

INTERFACE BD.	
J7-01	> EXP REQUEST
J7-02	> EXP REQUEST RTN
J7-03	> PREP REQUEST
J7-04	> PREP REQUEST RTN
J7-05	< PHOTO SPOT SELECT
J7-06	< PHOTO SPOT S. RTN
J7-07	< MAG2
J7-08	< MAG1
J7-09	< MAG RTN
J7-10	< EXP IN PROGRESS
J7-11	< EXP IN PROG. RTN
J7-12	< FLOURO SELECT
J7-13	< FLOURO SEL. RTN
J7-14	> GO TO GREY
J7-15	> GO TO BLACK
J7-16	> CAMERA COMMON
J7-17	> I.I. MAG 1 OUT
J7-18	> I.I. MAG 2 OUT
J7-19	> I.I. COMMON
J7-20	•

INTERFACE BD.	
J8-01	> CARRIGE LOCKS
J8-02	> CARRIGE LOCK RTN
J8-03	> COMPRESSION LOCK
J8-04	> COMPRESSION LOCK RTN
J8-05	> *
J8-06	> *
J8-07	> 4 WAY TOP HEAD
J8-08	> " " " RTN
J8-09	> " " " FOOT
J8-10	> " " " RTN
J8-11	> " " " BACK
J8-12	> " " " RTN
J8-13	> " " " FRONT
J8-14	> " " " RTN
J8-15	•
J8-16	> + 24 VDC
J8-17	> + 24 VDC
J8-18	•
J8-19	< RS232 GRND
J8-20	•

INTERFACE BD.	FRONT PANEL		FRONT PANEL	
J11-01	J2-01	> AUTO COLL. LAMP		
J11-02	J2-02	> RAPID LAMP		
J11-03	J2-03	> CONE LAMP		
J11-04	J2-04	> GRID LAMP		
J11-05	J2-05	> EXP LAMP		
J11-06	J2-06	> PREP LAMP		
J11-07	J2-07	> COMP. LOCK LAMP		
J11-08	J2-08	> CARRIGE LOCK LAMP		
J11-09	J2-09	< PREP + 24 VDC		
J11-10	J2-10	< EXP + 24VDC		
J11-11	J2-11	> COLL VSC		
J11-12	J2-12	> COLL VBSC		
J11-13	J2-13	< COLL VXFDL		
J11-14	J2-14	< COLL VXFDC		
J11-15	J2-15	> COLL VSC RTN		
J11-16	J2-16	< 4 WAY TOP HEAD		
J11-17	J2-17	< " " " FOOT		
J11-18	J2-18	< " " " BACK		
J11-19	J2-19	< " " " FRONT		
J11-20	J2-20		J3-06	< POWER ASSIST HEAD
J11-21	J2-21		J3-05	< " " FOOT
J11-22	J2-22		J3-04	< " " +5 VDC
J11-23	J2-23		J3-03	< " " UP
J11-24	J2-24		J3-02	< " " DOWN
J11-25	J2-25		J3-01	< " " GND
J11-26	J2-26		J4-03	> + VCC TILT
J11-27	J2-27		J4-01	> - VCC TILT
J11-28	J2-28		J4-02	< VARIABLE TILT OUT
J11-29	J2-29		J4-06	< TILT + 90
J11-30	J2-30		J4-05	< TILT 90
J11-31	J2-31		J4-04	< TILT COMMON
J11-32 •	J2-32			
J11-33 •	J2-33			
J11-34 •	J2-34			

Z80CPU	INTERFACE BD.			
J2-01	J2-01	> 2 ON 1 (LONG)		
J2-02	J2-02	> 3 ON 1		
J2-03	J2-03	> 4 ON 1		
J2-04	J2-04	> 6 ON 1		
J2-05	J2-05	> 9 ON 1		
J2-06	J2-06	> NORM		
J2-07	J2-07	> MAG 1		
J2-08	J2-08	> CLOCK		
J2-09	J2-09	> BRAKE		
J2-10	J2-10	> POWER MOTOR		
J2-11	J2-11	> DIRECTION		
J2-12	J2-12	> CLUTCH		
J2-13	J2-13	> EXP		
J2-14	J2-14	> PREP		
J2-15	J2-15	> 2 ON 1 (TRANS)		
J2-16	J2-16	> PHOTO PREP		
J2-17	J2-17	> PHOTO SELECT		
J2-18	J2-18	> MAG 2		
J2-19	J2-19	> AUTO COLL		
J2-20	J2-20	> GRID		
J2-21	J2-21	> CONE		
J2-22	J2-22	> EXTRA #1		
J2-23	J2-23	> RAPID		
J2-24	J2-24	< NOT USED		
J2-25	J2-25	< NOT USED		
J2-26	J2-26	< NOT USED		
J2-27	J2-27	< NOT USED		
J2-28	J2-28	< NOT USED		
J2-29	J2-29	< NOT USED		
J2-30	J2-30	< NOT USED		
J2-31	J2-31	< NOT USED		
J2-32	J2-32	< NOT USED		
J2-33	J2-33	< NOT USED		
J2-34	J2-34	< NOT USED		
J2-35	J2-35	< NOT USED		
J2-36	J2-36	< NOT USED		
J2-37	J2-37	< NOT USED		
J2-38	J2-38	< 510 OHM	J7-06	
J2-39	J2-39		J7-05	< PHOTO SPOT SELECT,
J2-40	J2-40	< 510 OHM		

Z80 CPU	INTERFACE BD.		INTERFACE BD.	
J3-01	J3-01		J6-09	< PARK POSITION LONG
J3-02	J3-02	< 510 OHMS		
J3-03	J3-03		J6-12	< PARK POSITION CROSS
J3-04	J3-04	< 510 OHMS		
J3-05	J3-05		J6-18	< LOAD POS
J3-06	J3-06	< 510 OHMS		
J3-07	J3-07		J6-15	< CASSETTE PRESENT
J3-08	J3-08	< 510 OHMS	J7-13	< EXP IN PROG. RTN
J3-09	J3-09		J7-10	< EXP IN PROGRESS
J3-10	J3-10	< 510 OHMS	J7-11	< FLOURO EN. RTN
J3-11	J3-11		J7-12	< FLOURO ENABLE
J3-12	J3-12	< 510 OHMS		
J3-13	J3-13		J5-01	< PARK BACK
J3-14	J3-14	< 510 OHMS		
J3-15	J3-15	< MAG 1		
J3-16	J3-16	< 510 OHMS		
J3-17	J3-17	< MAG 2		
J3-18	J3-18	< 510 OHMS		
J3-19	J3-19		J5-02	< CONE IN
J3-20	J3-20	< 510 OHMS		
J3-21	J3-21		J5-03	< CONE BACK
J3-22	J3-22	< 510 OHMS		
J3-23	J3-23		J5-04	< GRID IN
J3-24	J3-24	< 510 OHMS		
J3-25	J3-25		J5-05	< GRID BACK
J3-26	J3-26	< 510 OHMS		
J3-27	J3-27		J5-06	< EXTRA INPUT #1
J3-28	J3-28	< 510 OHMS		
J3-29	J3-29		J5-07	< EXTRA INPUT #2
J3-30	J3-30	< 510 OHMS		
J3-31	J3-31		J5-08	< EXTRA INPUT #3
J3-32	J3-32		J9-19	< RS232 INPUT
J3-33	J3-33		J9-20	> RS232 OUTPUT
J3-34	J3-34		J8-19	< RS232 GROUND
J3-35	J3-35	< GROUND		
J3-36	J3-36	< + 24 VDC		
J3-37	J3-37	•		
J3-38	J3-38	•		
J3-39	J3-39		J10-09	CPU RESET
J3-40	J3-40		J10-10	CPU RESET RTN

INTERFACE BD.	
J9-01	< P. A. HEAD
J9-02	< P. A. FOOT
J9-03	< P. A. COMM
J9-04	< P. A. UP
J9-05	< P. A. DOWN
J9-06	< P. A. COMM
J9-07	> + VCC TILT
J9-08	> - VCC TILT
J9-09	< VAR. TILT OUT
J9-10	< TILT + 90
J9-11	< TILT 90
J9-12	< TILT COMMON
J9-13	< COLL SFD REF
J9-14	< COLL SFD RET
J9-15	> COLL VIRC
J9-16	> COLL VIRL
J9-17	> COLL VXFDC
J9-18	> COLL VXFDL
J9-19	< RS232 INPUT IBM PIN 3
J9-20	> RS232 OUTPUT IBM PIN 5

INTERFACE BD.		
J10-01	< FOOT SWITCH (TABLE)	EXTERNAL CONN.
J10-02	< FOOT SWITCH RTN (TABLE)	
J10-03	•	
J10-04	•	
J10-05	•	
J10-06	•	
J10-07	•	
J10-08	•	
J10-09	CPU RESET	
J10-10	CPU RESET RTN	

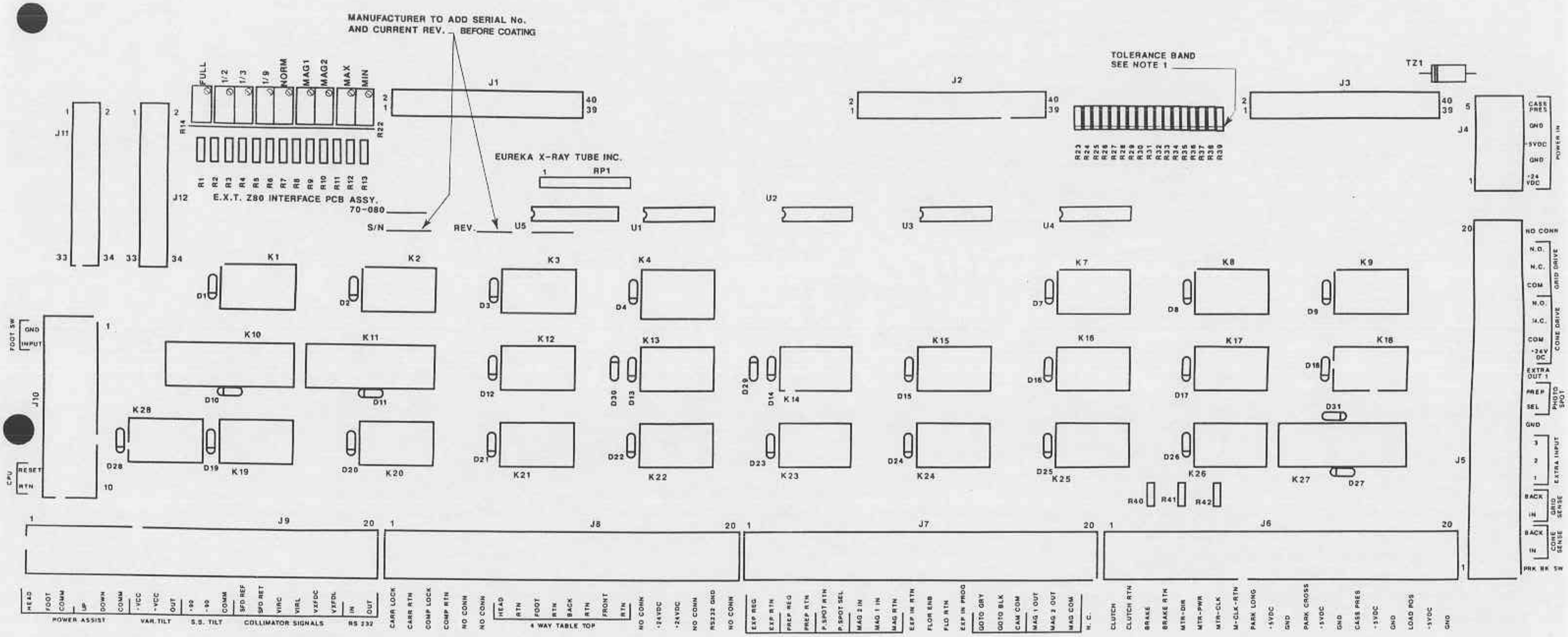
> DENOTES A SIGNAL OUTPUT
< DENOTES A SIGNAL INPUT
• DENOTES NO CONNECTION

APPROVALS	DATE
DRAWN R.PALAZZO	5/30/90
CHECKED	
ISSUED	
5041	

EUREKA X-RAY TUBE INC.

Z80 INTERFACE BD Figure 10.4
TERMINAL DESIGN. Page 10-10

SIZE D
FSCM NO.
DWG. NO. 70-08077
REV. A
SCALE
SHEET 3 OF 4


MANUFACTURER TO ADD SERIAL No.
AND CURRENT REV. BEFORE COATING
TOLERANCE BAND
SEE NOTE 1
TZ1
FULL
1/2
1/3
1/9
NORM
MAG1
MAG2
MAX
MIN
R14
R22
J1
J2
J3
J4
J5
J6
J7
J8
J9
J10
J11
J12
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R23
R24
R25
R26
R27
R28
R29
R30
R31
R32
R33
R34
R35
R36
R37
R38
R39
EUREKA X-RAY TUBE INC.
RP1
E.X.T. Z80 INTERFACE PCB ASSY.
70-080
S/N
REV.
U1
U2
U3
U4
U5
K1
K2
K3
K4
K7
K8
K9
K10
K11
K12
K13
K14
K15
K16
K17
K18
K19
K20
K21
K22
K23
K24
K25
K26
K27
K28
D1
D2
D3
D4
D7
D8
D9
D10
D11
D12
D13
D14
D15
D16
D17
D18
D19
D20
D21
D22
D23
D24
D25
D26
D27
D28
D29
D30
D31
R40
R41
R42
FOOT SW
GND
INPUT
CPU
RESET
RTN
CASS PRES
GND
+5VDC
GND
+24 VDC
POWER IN
NO CONN
N.O.
N.C.
COM
GRID DRIVE
CONE DRIVE
+24V DC
EXTRA OUT 1
PREP
SEL
PHOTO SPOT
GND
EXTRA INPUT
BACK
IN
GRID SENSE
CONE SENSE
PRK BK SW
HEAD
FOOT
COMM
DOWN
+VCC
-VCC
OUT
+90
-90
SFD REF
SFD RET
VIRC
VIRL
VXFDC
VXFDL
IN
POWER ASSIST
VAR.TILT
S.S. TILT
COLLIMATOR SIGNALS
RS 232
CARR LOCK
CARR RTN
COMP LOCK
COMP RTN
NO CONN
RTN
BACK
FRONT
4 WAY TABLE TOP
+24VDC
RS232 GND
EXP REG
EXP RTN
PREP REG
PREP RTN
P.SPOT RTN
P.SPOT SEL
MAG 2 IN
MAG 1 IN
MAG RTN
EXP IN RTN
FLOR ENB
FLO RTN
EXP IN PROG
GOTO GRY
GOTO BLK
CAM COM
MAG 1 OUT
MAG 2 OUT
MAG COM
N.C.
CLUTCH
CLUTCH RTN
BRAKE
BRAKE RTN
MTR-DIR
MTR-PWR
MTR-CLK
M-CLK-RTN
PARK LONG
+5VDC
GND
PARK CROSS
CASS PRES
LOAD POS

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL COLOR CODED RESISTORS TO BE INSERTED WITH TOLERANCE BAND TOWARD BOTTOM OR RIGHT HAND SIDE OF PCB AND VISIBLE.
2. ALL 1% RISITORS TO BE INSERTED WITH TOLERANCE BAND TOWARD BOTTOM OR RIGHT HAND SIDE OF PCB AND VISIBLE.
3. ALL CAPICATORS, DIODES ETC. TO BE INSERTED WITH VALUE, POLARITY AND / OR TYPE VISIBLE WHEN LOOKING DOWN ON COMPONENT SIDE OF PCB.
4. DIODE D30 ASSOCIATED WITH K13, D13 WAS D28
5. MASK OFF THE EXPOSED PINS OF J1 THRU J12 AND THE POTENTIOMETER ADJUSTMENT SCREW ON R14 THRU R22 BEFORE COATING.
6. BRUSH CONFORMAL COAT BOTH SIDES WITH SR 900 SILICONE (G.E.). REFER TO INSRUCTIONS FOR USE AND MATERIAL SAFTY DATA SHEET ON FILE WITH EUREKA FACILITY DEPT.
7. RESISTOR VALUES IN ( ) ARE USED WITH THE EUREKA UNDER TABLE COLLIMATOR.
8. RESISTOR * R1,R3, R5, R7 TO BE REPLACED WITH JUMPERS WHEN USING EUREKA UNDER TABLE COLLLLIMATOR
9. ALL DIODES, IN4002.
10. ALL RESISTANCE VALUES IN OHMS.

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ORIGINAL PRODUCT 5041

EUREKA X-RAY TUBE

Z80 INTERFACE BD ASSEMBLY

Figure 10.5
Page 10-11

SIZE C
DWG NO 70-08077
REV A
SHEET 4 OF 4

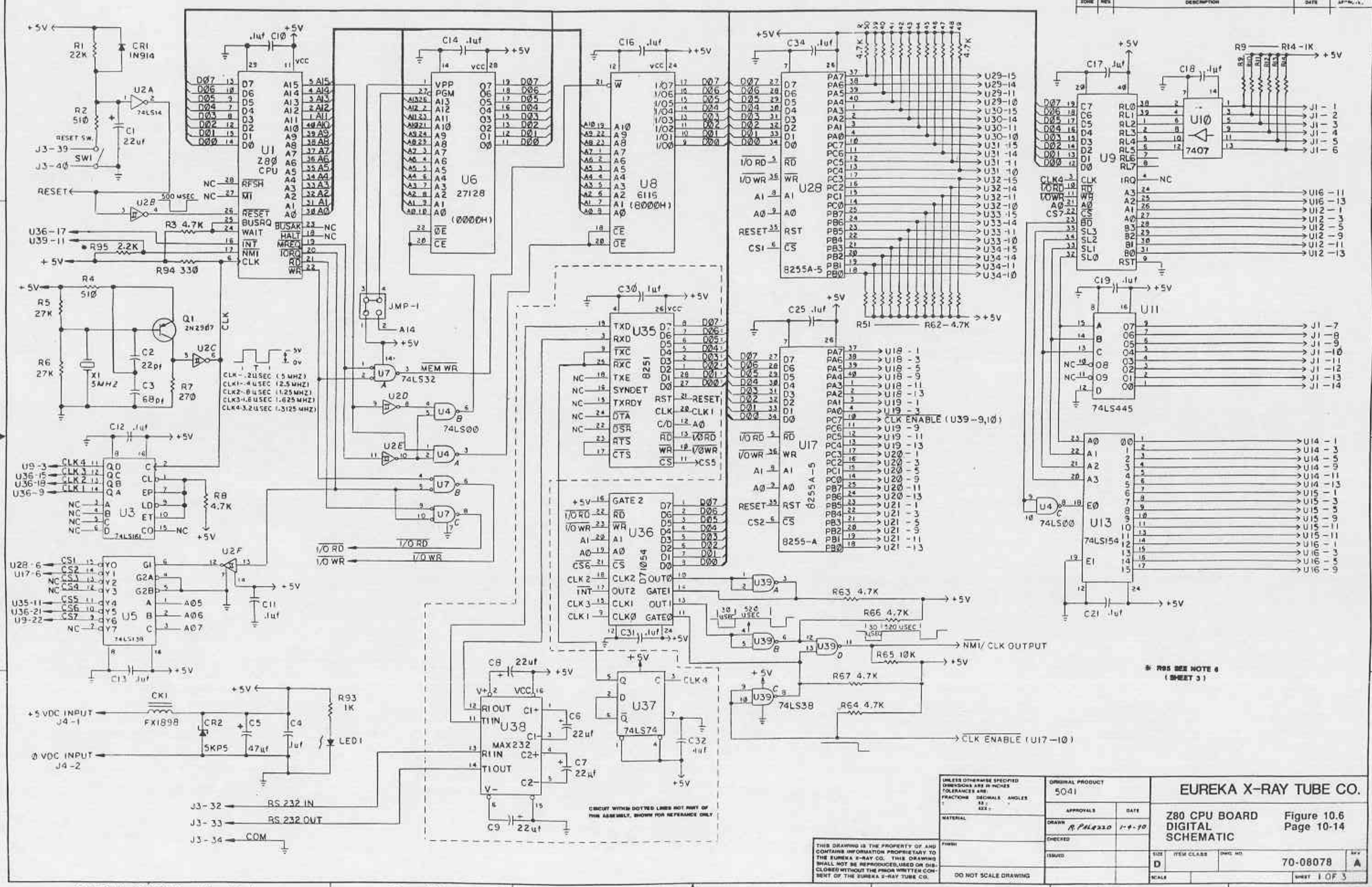
BILL OF MATERIALS
EXT SPOTFILM Z80 CPU PCB ASSEMBLY
70-08078

Item No.	Ref. Design	Part No.	Description	Vendor Part No.
1	U1	70-03133	I.C. Microprocessor, 40 Pin	Z8400
2	U2	70-03134	I.C. Hex Inverter, 14 Pin	SN74LS14N
3	U3	70-03135	I.C. Synch. 4-Bit Counter, 16 Pin	74LS161
4	U4	70-03136	I.C. Quad. 2-Input Nand Gate, 14 Pin	74LS00
5	U5	70-03116	I.C. Decoder/Demultiplexer, 16 Pin	74LS138
6	U6	70-08074	I.C. SFD Programmed EPROM, 28 Pin	M27128A
7	U8	70-03130	I.C. 2K X 8 RAM, 24 Pin	CXK5816PN-12L
8	U9	70-03118	I.C. Pro. Keyboard/Display/NT, 40 Pin`	M5L8279P-5
9	U10, 14, 15	70-03119	I.C. Hex Buffer Hi-voltage, 14 Pin	DM7407N
10	U11	70-03137	I.C. Decimal Decoder/Driver, 16 Pin	74LS445N
11	U12, 16, 18, 19-21	70-03138	I.C. Hex Inverting Buffer, 14 Pin	7406N
12	U13	70-03139	I.C. Decoder/Demultiplexer, 24 Pin	74LS154N
13	U17, 28	70-03140	I.C. Programmable I/O, 40 Pin	D8255A
14	U22-27, 29-34, 40-45	70-03045	I.C. Quad Opto-isolator, 16 Pin	ILQ-1
15	U39	70-03141	I.C. Quad 2-Input Nand Buffer, 14 Pin	74LS38
16	U36	70-03143	I.C. Programmable Timer/Count., 24 Pin	NEC D71054
17	U7	70-03142	I.C. Quad 2-Input Or-Gate, 14 Pin	SN74LS32N
18	C10-28, 31 33-35	70-02010	Capacitor, Ceramic, 0.1 mF 50V	
19	C1	70-02517	Capacitor, Elect., 22 mF 10V	
20	C2	70-02031	Capacitor, Mica, 22 mF, 300V	
21	C3	70-02026	Capacitor, Mica, 68 pF	
22	C4	70-02514	Capacitor, Elect., 4.7 mF, 35V	
23	C5, 30	70-02510	Capacitor, Tant., 100 mF	
24	CR1	70-03001	Diode	1N914/1N4148
25	CR2	70-03071	Tranzorb	MPTE-5
26	Q1	70-03407	Transistor	2N2907
27	XTAL-1	70-04272	Crystal, Nymph 5.000	NYP050N20
28	CK01	70-06524	Wire, 22 AWG, Solid	
29	R5, 6	70-00072	Resistor, Carb. Film, 1/4W, 27K, ±5%	
30	R3, 8, 39-64, 66, 67	70-00056	Resistor, Carb. Film, 1/4W, 4.7K, ±5%	
31	R2, 4, 17, 20, 22-38, 68, 79, 81-92	70-00035	Resistor, Carb. Film, 1/4W, 510Ω, ±5%	
32	R7, 15, 16, 21	70-00028	Resistor, Carb. Film, 1/4W, 270Ω, ±5%	
33	R9-14, 93	70-00042	Resistor, Carb. Film, 1/4W, 1kΩ, ±5%	

EXT Z80 INTERFACE PCB ASSEMBLY
70-08078
Table 10.3

Item No.	Ref. Design	Part No.	Description	Vendor Part No.
34	J1-3	70-04527	Header, Conn. 3M, 40 Pin	3595-6002
35	J4	70-04528	Pin Strip, 2 Pin, Z5.584.2125	814055
36	SW1	70-04257	Switch, Pushbutton	
37		21-20260	SR900 Silicone Resin. Solution	
38		70-06280	Z80 - CPU PCB	
39	R1	70-00062	Resistor, 8.2KΩ, 1/4W, ±5%	
40	U6	70-04219	I.C. Socket, 28 Pin	
41	LED1	70-03062	LED, Green	
42	R94	70-	Resistor, 330Ω, 1/4W, ±5%	
43	R65	70-00064	Resistor, 10KΩ, 1/4W, ±5%	
44	R95	70-00048	Resistor, 2.2KΩ, 1/4W, ±5%	

EXT Z80 INTERFACE PCB ASSEMBLY
70-08078
Table 10.3 (Cont.)



U1 Z80 CPU
U6 27128 (0000H)
U8 6116 (8000H)
U28 8255A-5
U9
U10 7407
U11 74LS445
U13 74LS154
U17 8255A-5
U35 8251
U36 D71054
U37 74LS74
U38 MAX232
U3 74LS161
U5 74LS138
U7 74LS32
U4 74LS00
U39 74LS38
U2A 74LS14
JMP-1
Q1 2N2907
X1 5MHZ
CR1 1N914
CR2 5KP5
CK1 FX1898
LED1
SW1 RESET SW.
R1 22K
R2 510
R3 4.7K
R4 510
R5 27K
R6 27K
R7 270
R8 4.7K
R93 1K
R94 330
* R95 2.2K
R9 — R14 - 1K
R51 — R62 - 4.7K
R63 4.7K
R64 4.7K
R65 10K
R66 4.7K
R67 4.7K
C1 22uf
C2 22pf
C3 68pf
C5 47uf
C6 22uf
C7 22uf
C8 22uf
C9 22uf
500 MSEC
CLK - .2USEC (5 MHZ)
CLK1 - .4USEC (2.5 MHZ)
CLK2 - .8USEC (1.25 MHZ)
CLK3 - 1.6USEC (.625 MHZ)
CLK4 - 3.2USEC (.3125 MHZ)
MEM WR
I/O RD
I/O WR
+5 VDC INPUT J4-1
0 VDC INPUT J4-2
J3-32 RS 232 IN
J3-33 RS 232 OUT
J3-34 COM
J3-39
J3-40
RESET
NMI / CLK OUTPUT
CLK ENABLE (U17-10)
CLK ENABLE (U39-9,10)
30 USEC
520 USEC

* R95 SEE NOTE 6 (SHEET 3)

CIRCUIT WITHIN DOTTED LINES NOT PART OF THIS ASSEMBLY. SHOWN FOR REFERANCE ONLY

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

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ORIGINAL PRODUCT 5041

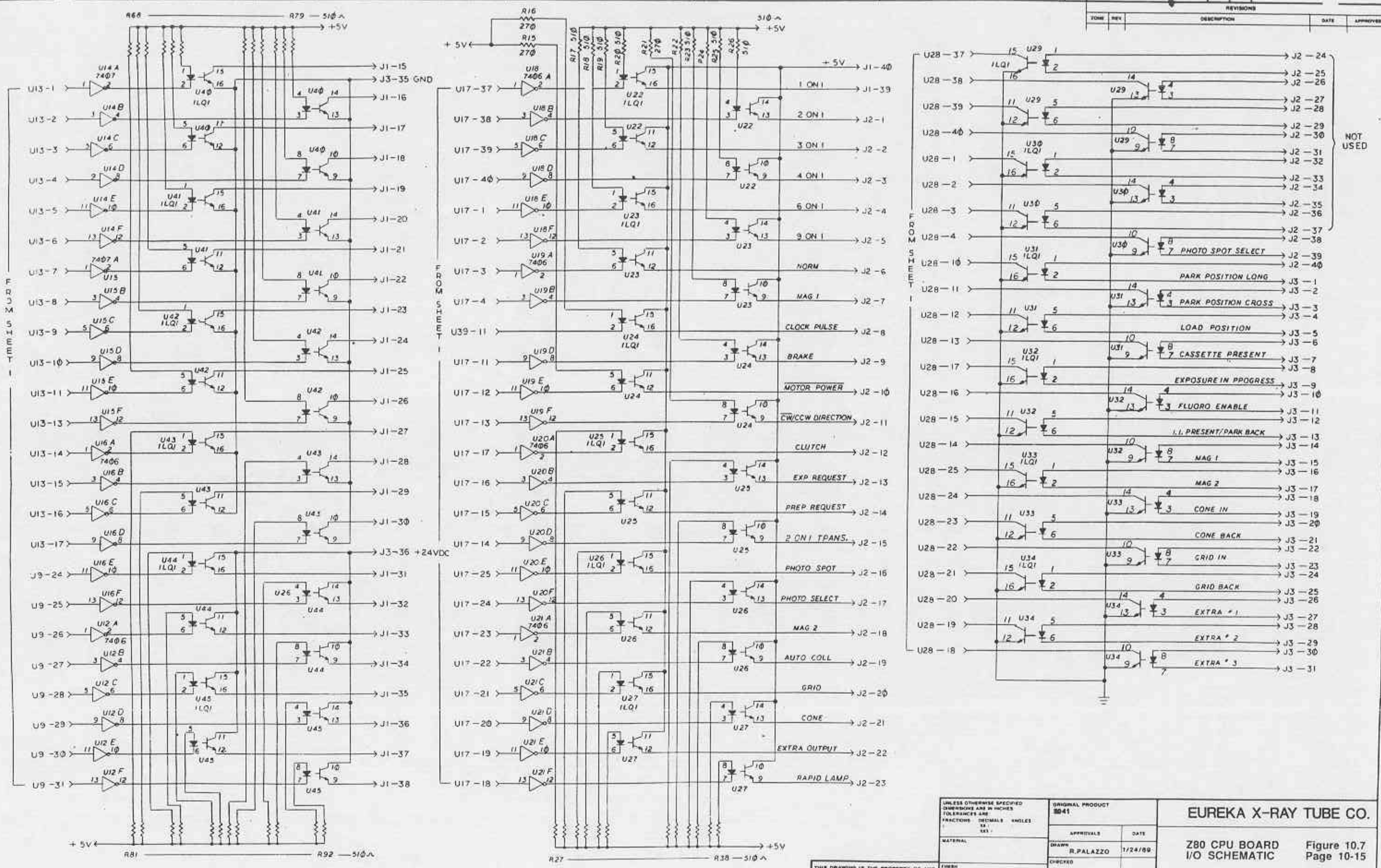
APPROVALS	DATE
DRAWN R. Palazzo	1-4-90
CHECKED	
ISSUED	

EUREKA X-RAY TUBE CO.

Z80 CPU BOARD
DIGITAL
SCHEMATIC

Figure 10.6
Page 10-14

SIZE D ITEM CLASS DWG. NO. 70-08078 REV A
SCALE SHEET 1 OF 3


FROM SHEET 1
U13-1
U13-2
U13-3
U13-4
U13-5
U13-6
U13-7
U13-8
U13-9
U13-10
U13-11
U13-13
U13-14
U13-15
U13-16
U13-17
U9-24
U9-25
U9-26
U9-27
U9-28
U9-29
U9-30
U9-31
U14A 7407
U40 ILQ1
U41 ILQ1
U42 ILQ1
U43 ILQ1
U44 ILQ1
U45 ILQ1
R68
R79 — 510Ω
+5V
R81
R92 — 510Ω
J1-15
J3-35 GND
J1-16
J1-17
J1-18
J1-19
J1-20
J1-21
J1-22
J1-23
J1-24
J1-25
J1-26
J1-27
J1-28
J1-29
J1-30
J3-36 +24VDC
J1-31
J1-32
J1-33
J1-34
J1-35
J1-36
J1-37
J1-38
U17-37
U17-38
U17-39
U17-40
U17-1
U17-2
U17-3
U17-4
U39-11
U17-11
U17-12
U17-13
U17-17
U17-16
U17-15
U17-14
U17-25
U17-24
U17-23
U17-22
U17-21
U17-20
U17-19
U17-18
U18 7406 A
R16 270
R15 270
R17–R26 510
R27
R38 — 510Ω
1 ON I
J1-40
J1-39
2 ON I
J2-1
3 ON I
J2-2
4 ON I
J2-3
6 ON I
J2-4
9 ON I
J2-5
NORM
J2-6
MAG 1
J2-7
CLOCK PULSE
J2-8
BRAKE
J2-9
MOTOR POWER
J2-10
CW/CCW DIRECTION
J2-11
CLUTCH
J2-12
EXP REQUEST
J2-13
PREP REQUEST
J2-14
2 ON I TRANS.
J2-15
PHOTO SPOT
J2-16
PHOTO SELECT
J2-17
MAG 2
J2-18
AUTO COLL
J2-19
GRID
J2-20
CONE
J2-21
EXTRA OUTPUT
J2-22
RAPID LAMP
J2-23
U28-37
U28-38
U28-39
U28-40
U28-1
U28-2
U28-3
U28-4
U28-10
U28-11
U28-12
U28-13
U28-17
U28-16
U28-15
U28-14
U28-25
U28-24
U28-23
U28-22
U28-21
U28-20
U28-19
U28-18
U29 ILQ1
U30 ILQ1
U31 ILQ1
U32 ILQ1
U33 ILQ1
U34 ILQ1
J2-24 … J2-38
NOT USED
PHOTO SPOT SELECT
J2-39
J2-40
PARK POSITION LONG
J3-1
J3-2
PARK POSITION CROSS
J3-3
J3-4
LOAD POSITION
J3-5
J3-6
CASSETTE PRESENT
J3-7
J3-8
EXPOSURE IN PROGRESS
J3-9
J3-10
FLUORO ENABLE
J3-11
J3-12
I.I. PRESENT/PARK BACK
J3-13
J3-14
MAG 1
J3-15
J3-16
MAG 2
J3-17
J3-18
CONE IN
J3-19
J3-20
CONE BACK
J3-21
J3-22
GRID IN
J3-23
J3-24
GRID BACK
J3-25
J3-26
EXTRA #1
J3-27
J3-28
EXTRA #2
J3-29
J3-30
EXTRA #3
J3-31
DWG. NO
SH
REV
REVISIONS
ZONE
DESCRIPTION
DATE
APPROVED

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE
FRACTIONS DECIMALS ANGLES
.XX
.XXX

MATERIAL

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5941

APPROVALS	DATE
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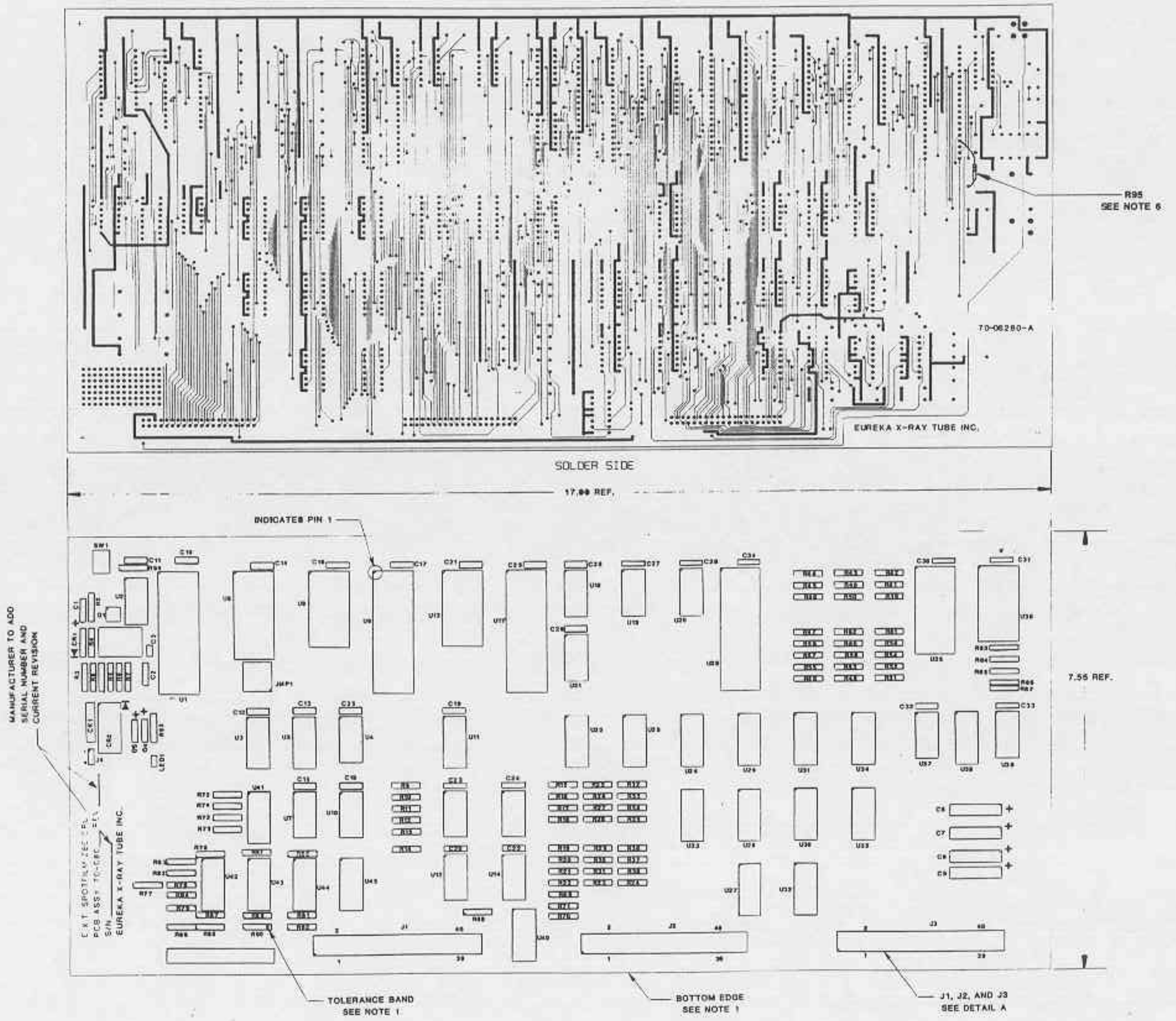
CHECKED	
ISSUED	

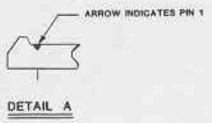
EUREKA X-RAY TUBE CO.

Z80 CPU BOARD
I/O SCHEMATIC

Figure 10.7
Page 10-15

SIZE D
ITEM CLASS
DWG. NO 70-08078
REV A
SCALE
SHEET 2 OF 3


R95
SEE NOTE 6
70-08260-A
EUREKA X-RAY TUBE INC.
SOLDER SIDE
17.00 REF.
INDICATES PIN 1
7.55 REF.
MANUFACTURER TO ADD
SERIAL NUMBER AND
CURRENT REVISION
EXT. SPOTFILM ZEE
PCB ASSY 70-08
S/N
EUREKA X-RAY TUBE INC.
J1
J2
J3
TOLERANCE BAND
SEE NOTE 1
BOTTOM EDGE
SEE NOTE 1
J1, J2, AND J3
SEE DETAIL A


ARROW INDICATES PIN 1

DETAIL A

NOTES:

(UNLESS OTHERWISE SPECIFIED)

1 ALL COLOR CODED RESISTORS TO BE INSERTED WITH TOLERANCE BAND TOWARD BOTTOM OR RIGHT HAND SIDE OF P.C.B.

2 ALL 1% RESISTORS TO BE INSERTED SO THAT RESISTANCE VALUE IS VISIBLE WHEN LOOKING DOWN ON COMPONENT SIDE OF P.C.B.

3 ALL CAPACITORS, DIODE'S ETC. TO BE INSERTED WITH VALUE AND/OR TYPE VISIBLE WHEN LOOKING DOWN ON COMPONENT SIDE OF P.C.B.

4 MASK OFF EXPOSED PINS OF CONNECTORS J1 THRU J4, EXPOSED BUTTON OF SW1 AND THE EXPOSED CONTACT PINS OF THE SOCKET FOR U6 BEFORE COATING.

5 BRUSH CONFORMAL COAT BOTH SIDES WITH SR 900 SILICONE (G.E.). REFER TO INSRUCTIONS FOR USE AND MATERIAL SAFTY DATA SHEET ON FILE WITH EUREKA FACILITY DEPT.

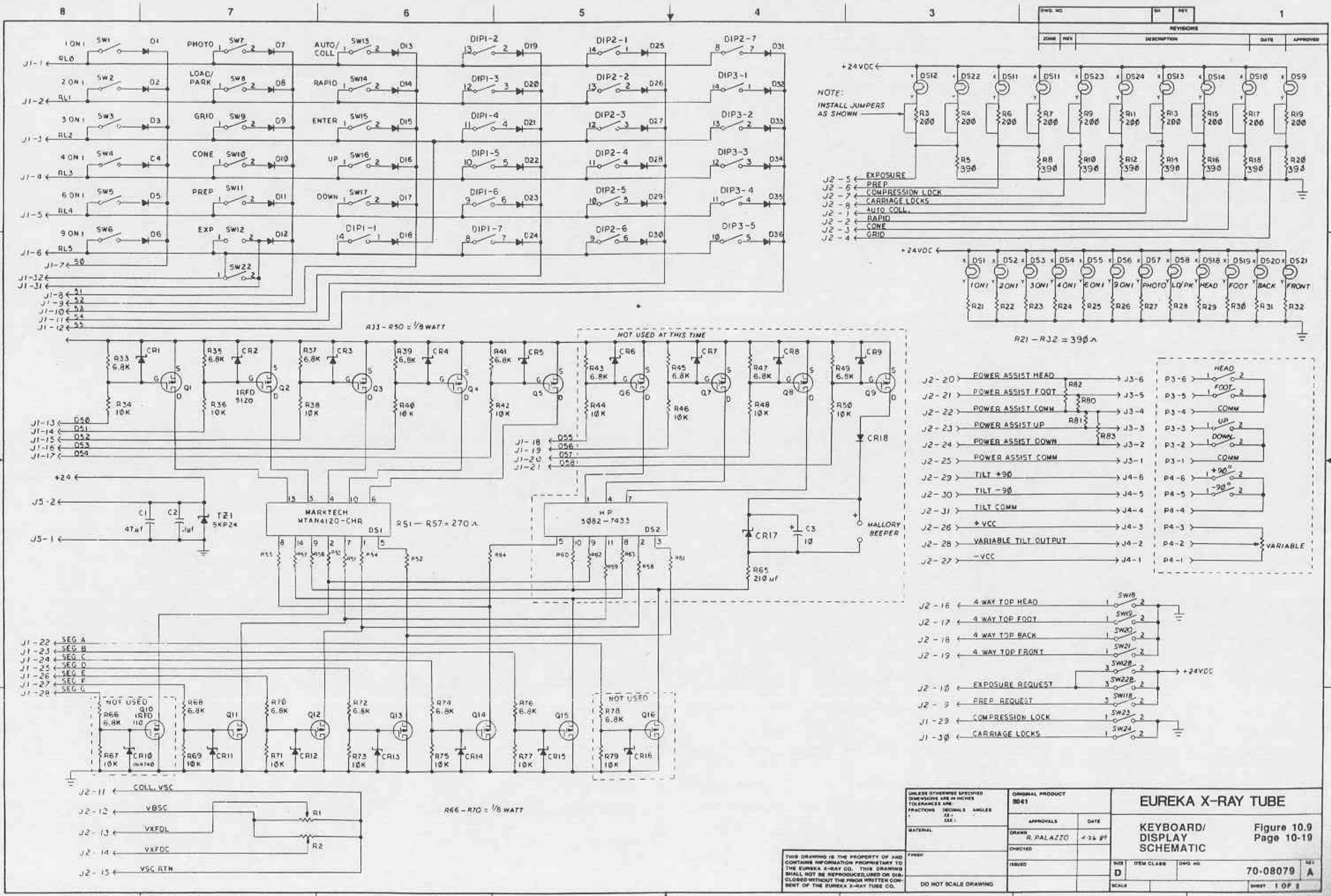
6. INSERT R95 TO PIN 17 OF U1 TO +5V AS SHOWN. (SOLDER SIDE)

ORIGINAL PRODUCT 5041	EUREKA X-RAY TUBE
DRAWN R.PALAZZO 3/21/88	Z80 CPU BOARD ASSEMBLY
	Figure 10.8 Page 10-16
SIZE D	70-08078 REV A
	SHEET 3 OF 3

BILL OF MATERIALS
EXT KEYBOARD/DISPLAY
70-08079

Item No.	Ref. Design	Part No.	Description	Vendor Part No.
1	R1, 2	70-00610	Resistor, Slide Pot, 1KΩ	PL40
2	R5, 8, 65	70-00025	Resistor, Carb. Film, 1/4W, 200Ω, ±5%	
3	R10, 12, 14, 16, 18, 20-32	70-00032	Resistor, Carb. Film, 1/4W, 390Ω, ±5%	
4	R34, 36, 38, 40, 42, 69, 71, 73, 75, 77	70-00064	Resistor, Carb. Film, 1/4W, 10K, ±5%	
5	R33, 35, 37, 39, 41, 68, 70, 72, 74, 76	70-00060	Resistor, Carb. Film, 1/4W, 6.8K, ±5%	
6	R51-57	70-00028	Resistor, Carb. Film, 1/4W, 270Ω, ±5%	
7	R80-83	70-00042	Resistor, Carb. Film, 1/4W, 1K, ±5%	
8	CR1-5, CR11-15	70-03026	Diode	1N4739A
9	D1-24	70-03001	Diode	1N914/1N4148
10	C1	70-02519	Capacitor, Tant., 47mF, 35V	
11	C2	70-02010	Capacitor, Tant., 0.1 mF, 50V	
12	Q11-15	70-03408	Hex FET, N-Channel	IRFD110
13	Q1-5	70-03409	Hex FET, P-Channel	IRFD9120
14	J1-J2	70-04526	Header, 34 Pin	821-A034P-AFA00
15	J3-5	70-04528	Pin Strips, 2-6 Pin, 1-2 Pin	05-594-8400
16	SW23, 24	70-04258	Switch, Pushbutton	99-481
17	SW1-10 SW12-14	70-04259	Switch, Pushbutton	99-451
18	SW11	70-04260	Switch, Pushbutton, Double Width	99-406
19	DS1	70-03073	5 X & Dot Matrix Display	MTAN 412D-AHR
20		70-04703	Lens Holder	99-901-9
21		70-04268	Lamp, Incandescent	11-903-3
22		70-10842	Screw, Metric, M3	
23	JMP1-9	70-06254	Jumper Wire	
24		21-20260	SR900 Silicone Resin Solution	
25		70-06279	SFD Keyboard/Display	
26		70-04599	Terminal Strip, 7 Pin	
27	RP1	70-00513	Resistor Array, 220Ω, 6 Pin SIP	CSC06A-01

EXT Z80 INTERFACE PCB ASSEMBLY
70-08079
Table 10.4



NOTE:
INSTALL JUMPERS AS SHOWN
+24VDC
R33 - R50 = 1/8 WATT
NOT USED AT THIS TIME
R21 - R32 = 390 Ω
MARKTECH MTAN4120-CHR DS1
R51 - R57 = 270 Ω
HP 5082-7433 DS2
MALLORY BEEPER
R65 210 uf
TZ1 5KP24
C1 47uf
C2 .1uf
CR17
C3 10
CR18
IRFD 9120
J2-5 EXPOSURE
J2-6 PREP
J2-7 COMPRESSION LOCK
J2-8 CARRIAGE LOCKS
J2-1 AUTO COLL.
J2-2 RAPID
J2-3 CONE
J2-4 GRID
1ON1
2ON1
3ON1
4ON1
6ON1
9ON1
PHOTO
LD/PK
HEAD
FOOT
BACK
FRONT
J2-20 POWER ASSIST HEAD J3-6
J2-21 POWER ASSIST FOOT J3-5
J2-22 POWER ASSIST COMM J3-4
J2-23 POWER ASSIST UP J3-3
J2-24 POWER ASSIST DOWN J3-2
J2-25 POWER ASSIST COMM J3-1
J2-29 TILT +90 J4-6
J2-30 TILT -90 J4-5
J2-31 TILT COMM J4-4
J2-26 + VCC J4-3
J2-28 VARIABLE TILT OUTPUT J4-2
J2-27 -VCC J4-1
P3-6 HEAD
P3-5 FOOT
P3-4 COMM
P3-3 UP
P3-2 DOWN
P3-1 COMM
P4-6 +90°
P4-5 -90°
P4-4
P4-3
P4-2 VARIABLE
P4-1
J2-16 4 WAY TOP HEAD SW18
J2-17 4 WAY TOP FOOT SW19
J2-18 4 WAY TOP BACK SW20
J2-19 4 WAY TOP FRONT SW21
SW128 +24VDC
J2-10 EXPOSURE REQUEST SW22B
J2-9 PREP REQUEST SW118
J1-29 COMPRESSION LOCK SW23
J1-30 CARRIAGE LOCKS SW24
SW1 1ON1 D1 J1-1 RL0
SW2 2ON1 D2 J1-2 RL1
SW3 3ON1 D3 J1-3 RL2
SW4 4ON1 D4 J1-4 RL3
SW5 6ON1 D5 J1-5 RL4
SW6 9ON1 D6 J1-6 RL5
J1-7 S0
J1-32
J1-31
J1-8 S1
J1-9 S2
J1-10 S3
J1-11 S4
J1-12 S5
PHOTO SW7 D7
LOAD/PARK SW8 D8
GRID SW9 D9
CONE SW10 D10
PREP SW11 D11
EXP SW12 D12
SW22
AUTO/COLL SW13 D13
RAPID SW14 D14
ENTER SW15 D15
UP SW16 D16
DOWN SW17 D17
DIP1-1 D18
DIP1-2 D19
DIP1-3 D20
DIP1-4 D21
DIP1-5 D22
DIP1-6 D23
DIP1-7 D24
DIP2-1 D25
DIP2-2 D26
DIP2-3 D27
DIP2-4 D28
DIP2-5 D29
DIP2-6 D30
DIP2-7 D31
DIP3-1 D32
DIP3-2 D33
DIP3-3 D34
DIP3-4 D35
DIP3-5 D36
J1-13 DS0
J1-14 DS1
J1-15 DS2
J1-16 DS3
J1-17 DS4
J1-18 DS5
J1-19 DS6
J1-20 DS7
J1-21 DS8
+24
J5-2
J5-1
J1-22 SEG A
J1-23 SEG B
J1-24 SEG C
J1-25 SEG D
J1-26 SEG E
J1-27 SEG F
J1-28 SEG G
NOT USED
Q10 IRFD 110
CR10 1N4740
R66 - R70 = 1/8 WATT
J2-11 COLL. VSC
J2-12 VBSC
J2-13 VXFDL
J2-14 VXFDC
J2-15 VSC RTN
R1
R2

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES

MATERIAL

FINISH

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APPROVALS	DATE
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ISSUED	

EUREKA X-RAY TUBE

KEYBOARD/
DISPLAY
SCHEMATIC

Figure 10.9
Page 10-19

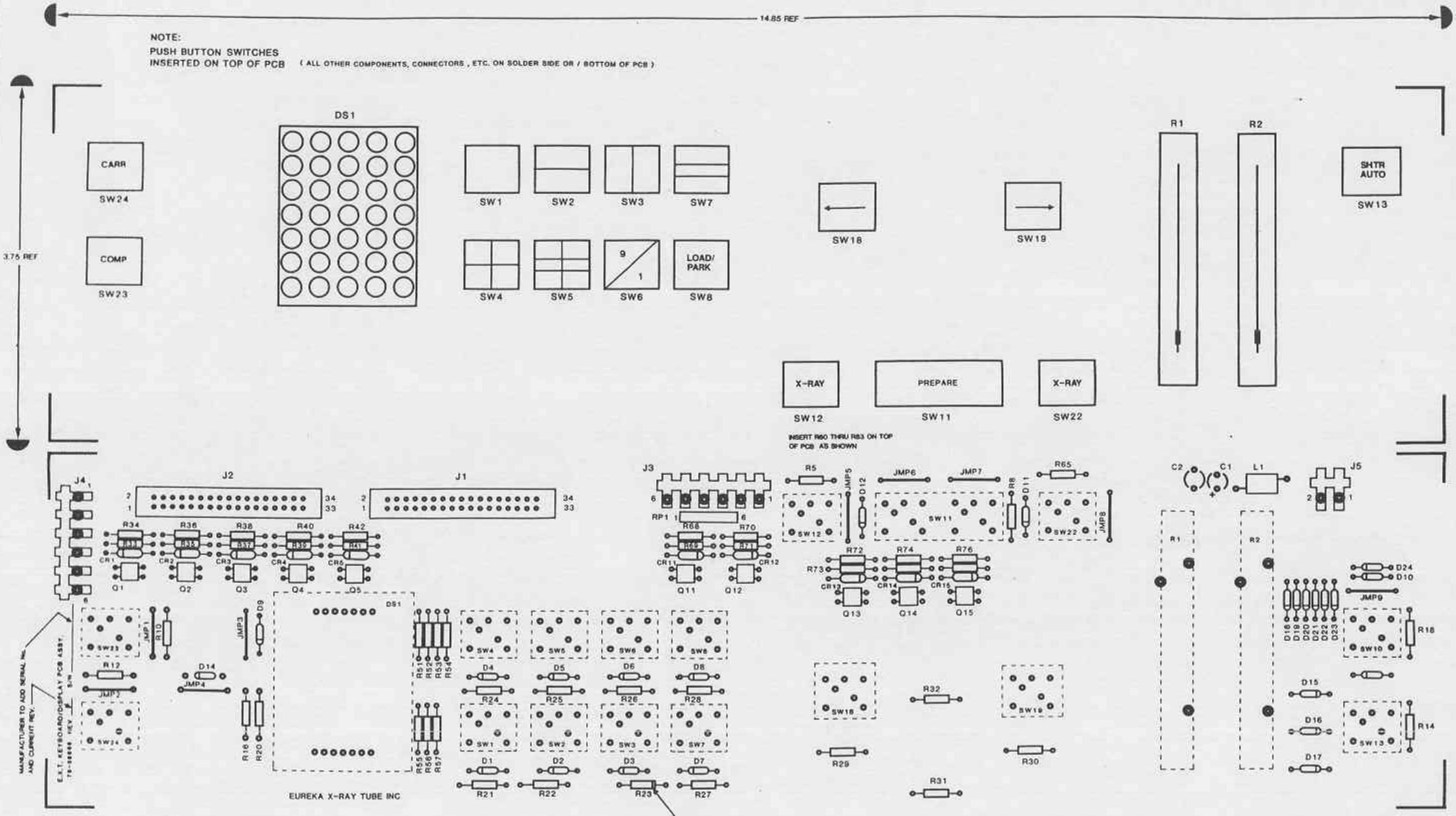
SIZE D ITEM CLASS DWG NO 70-08079 REV A

SCALE SHEET 1 OF 1

DWG NO.	SH	REV

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED



14.85 REF
3.75 REF
DS1
CARR
SW24
COMP
SW23
SW1
SW2
SW3
SW7
9
1
LOAD/ PARK
SW4
SW5
SW6
SW8
SW18
SW19
R1
R2
SHTR AUTO
SW13
X-RAY
SW12
PREPARE
SW11
X-RAY
SW22
J4
J2
J1
J3
2
1
34
33
6
1
RP1
R5
JMP5
D12
JMP6
JMP7
R8
D11
R65
JMP8
C2
C1
L1
J5
R34
R36
R38
R40
R42
R68
R70
CR1
CR2
CR3
CR4
CR5
CR11
CR12
Q1
Q2
Q3
Q4
Q5
Q11
Q12
R72
R73
R74
R76
CR13
CR14
CR15
Q13
Q14
Q15
D24
D10
JMP9
D18
D19
D20
D21
D22
D23
R18
R14
D15
D16
D17
JMP1
R10
JMP3
D9
D14
JMP4
R12
JMP2
R19
R20
R51
R52
R53
R54
R55
R56
R57
SW4
SW5
SW6
SW8
SW1
SW2
SW3
SW7
SW10
SW13
D4
D5
D6
D8
R24
R25
R26
R28
D1
D2
D3
D7
R21
R22
R23
R27
R29
R30
R31
R32
E.X.T. KEYBOARD/DISPLAY PCB ASSY. 70-08080 REV. A S/N
TOLERANCE BAND SEE NOTE 1

NOTE:
PUSH BUTTON SWITCHES
INSERTED ON TOP OF PCB (ALL OTHER COMPONENTS, CONNECTORS , ETC. ON SOLDER SIDE OR / BOTTOM OF PCB)

INSERT R60 THRU R63 ON TOP OF PCB AS SHOWN

MANUFACTURER TO ADD SERIAL No. AND CURRENT REV.

EUREKA X-RAY TUBE INC

NOTES: (UNLESS OTHERWISE SPECIFIED.)

1 ALL COLOR CODED RESISTORS TO BE INSERTED WITH TOLERANCE BAND TOWARD BOTTOM OR RIGHT HAND SIDE OF PCB AND VISIBLE.

2 ALL 1% RESISTORS TO BE INSERTED WITH TOLERANCE BAND TOWARD BOTTOM OR RIGHT HAND SIDE OF PCB

3 ALL CAPACITORS,DIODES ETC. TO BE INSERTED WITH VALUE, POLARITY AND / OR TYPE VISIBLE WHEN LOOKING DOWN ON COMPONENT SIDE OF PCB.

4 BRUSH CONFORMAL COAT BOTH SIDES WITH SR 900 SILICONE (G.E.). REFER TO INSRUCTIONS FOR USE AND MATERIAL SAFTY DATA SHEET ON FILE WITH EUREKA FACILITY DEPT.

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DIMENSIONS ARE IN INCHES
TOLERANCES ARE
FRACTIONS DECIMALS ANGLES
XX ±
XXX ±

MATERIAL

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8041

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EUREKA X-RAY TUBE

KEYBOARD/
DISPLAY
ASSEMBLY

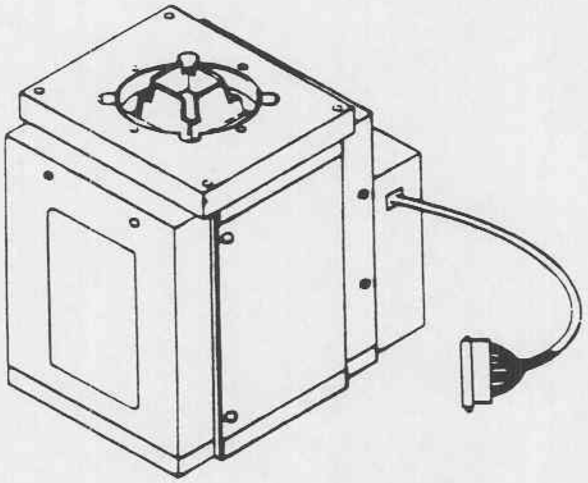
Figure 10.10
Page 10-20

SIZE	ITEM CLASS	DWG. NO.	REV
D		70-08079	A

SCALE
SHEET 2 OF 2

CHAPTER 11

UNDER-TABLE COLLIMATOR



EUREKA

Eureka X-Ray Tube, Inc.
600 W. University Drive
Arlington Heights, IL 60004

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(800) 545-3128
FAX (708) 394-5903
TWX (910) 221-5632

LINEAR™ FSE

Automatic Undertable Collimating System
for Use With the
EXT-950 (DPSC) Spotfilm Device

Installation
Operation
and Maintenance

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00-02-1408

TABLE OF CONTENTS

SECTION PAGE

1.0 INTRODUCTION

1.1 You Have Legal Obligations.......... 1-3
1.2 Background.......... 1-3
1.3 Linear™ Series Collimator Features.......... 1-4
1.4 Standard Features.......... 1-5
1.5 SPECIFICATIONS.......... 1-5
1.6 Radiation and Mechanical/Electrical Warning.......... 1-7
1.7 COMPATIBILITY.......... 1-8
1.8 MAINTENANCE.......... 1-8
1.9 COMPLIANCE REQUIREMENTS.......... 1-9

2.0 INSTALLATION

2.1 Unpacking.......... 2-3
2.2 Equipment Supplied.......... 2-3
2.3 Collimator Mounting and Interfacing.......... 2-3
2.4 Logic Assembly Interfacing.......... 2-9
2.5 SID Monitor Potentiometer Adjustment.......... 2-10

3.0 CALIBRATION

3.1 General Description.......... 3-3
3.2 Service Adjustments, Controls and Indicators.......... 3-4
3.3 +5 Volt A/D Reference Calibration.......... 3-11
3.4 Spotfilm Reference Voltage Calibration.......... 3-11
3.5 Collimator Head Reference Voltage Calibration.......... 3-11
3.6 Continuous SID Adjustment.......... 3-11
3.7 Collimator Shutter Calibration.......... 3-13

4.0 OPERATIONAL CHECKOUT PROCEDURE

4.1 Description.......... 4-3
4.2 Collimator Centering Alignment.......... 4-3
4.3 Fluoroscopic Image Size (I.I.) Adjustment.......... 4-3
4.4 1-ON-1 (Full) Film Adjustment.......... 4-4
4.5 2-ON-1 Longitudinal Film Adjustment.......... 4-4
4.6 2-ON-1 Transverse Film Adjustment.......... 4-5
4.7 3-ON-1 Film Adjustment.......... 4-5
4.8 4-ON-1 Film Adjustment.......... 4-5
4.9 6-ON-1 Film Adjustment.......... 4-6
4.10 9-ON-1 Film Adjustment.......... 4-6
4.11 SID Tracking Verification.......... 4-6

SECTION PAGE

5.0 COMPLIANCE VERIFICATION

5.1 Verification Tests to be Performed........ 5-3
XR8-2.09 Beam Quality........ 5-4
XR8-2.16 Minimum Field Size........ 5-9
XR8-2.20 X-Ray Field Limitation and Alignment........ 5-11
XR8-2.24 Fluoroscopic X-Ray Field Limitation........ 5-14
XR8-2.25 Fluoro Source-to-Skin Distance........ 5-22
XR8-2.27 Primary Barrier - X-Ray Lockout........ 5-25
XR8-2.29 Alignment of X-F Edges to Image Receptor........ 5-25
XR8-2.30 Alignment of Center of X-F to Image Receptor........ 5-27
Record Sheet........ 5-31

6.0

NOT APPLICABLE FOR THIS MANUAL

7.0 THEORY OF OPERATION

7.1 Mechanical Operation........ 7-4
7.2 Electronic Operation........ 7-4

8.0 APPENDIX

Definitions........ 8-2

9.0 BILLS OF MATERIAL AND SCHEMATICS

TABLE OF CONTENTS

List of Figures

SECTION	FIGURE		PAGE
2.0	2.1	Component Identification	2-2
	2.2	Collimator to Focal Spot Distance	2-4
	2.3	Collimator/Tube Mounting	2-6
	2.4	Collimator Interconnect Cabling	2-7
	2.5	J2 Logic Wiring	2-8
	2.6	J1 Logic Wiring	2-9
3.0	3.1	Logic Board Calibration	3-2
4.0	4.1	Collimator Centering	4-2
	4.2	Fluoroscopic I.R. Shutter Alignment	4-2
5.0	5.1	CDRH/FDA Compliance Test Stand	5-2
	5.2	Compliance Test Stand Detail	5-2
	5.3	Beam Quality Graphing Examples	5-8
	5.4	Fluoroscopic X-ray Field Limitation, Test Stand Method	5-15
	5.5	Fluoroscopic X-ray Field Limitation, Direct Method	5-17
	5.6	Image Intensified Fluoroscope, Test Set-Up	5-20
	5.7	Image Intensified Fluoroscope, Metal Marker Method, Inside Edge	5-20
	5.8	Image Intensified Fluoroscope, Metal Marker Method, Outside Edge	5-21
	5.9	Undertable Tube, Test Set-Up	5-21
	5.10	Focal Spot Geometry	5-24
	5.11	Calculation Example	5-29
	5.12	Spotfilm X-ray Field Limitation, Test Stand Method, Reference	5-30
	5.13	Spotfilm X-ray Field Limitation, Test Stand Method, Actual	5-30
7.0	7.1	Block Diagram, Analog Section	7-2
	7.2	Block Diagram, Digital Section	7-3
9.0	9.1	Undertable Logic PCB Digitial Schematic (70-08084)	9-5
	9.2	Undertable Logic PCB Analog Schematic (70-08084)	9-6
	9.3	Undertable Logic PCB Assembly Drawing (70-08084)	9-7
	9.4	FSE Driver PCB Assembly Schematic (70-08083)	9-10
	9.5	FSE Driver PCB Assembly (70-08083)	9-11

TABLE OF CONTENTS

List of Tables

SECTION	TABLE		PAGE
3.0	3-1	Current vs. SID in Ohms/In.	3-12
5.0	5-1	Minimum Beam Quality Requirements	5-4
	5-2	Aluminum Equivalent of Primary Beam Total Filtration	5-5
	5-3	Highest Design Operating Range	5-7
	5-4	Half-Value Layers as a Function of Filtration and Tube Potential for Diagnostic Units	5-7
8.0	8-1	Tube Mounting Information	8-3
9.0	9-1	Bills of Material - Undertable Logic PCB Assembly (70-08084)	9-3
	9-2	Bills of Material - FSE Driver PCB Assembly (70-08083)	9-8

SECTION 1.0

INTRODUCTION

NO TEXT

1.0 INTRODUCTION

This manual contains information for the assembly, installation, adjustment, testing and maintenance of the LINEAR ™ FSE series of fluoroscopic collimators manufactured by EUREKA X-RAY TUBE, INC.

1.1 YOU HAVE LEGAL OBLIGATIONS

The manufacturers of beam limiting devices are required to provide instructions for the assembly, installation, adjustment and testing adequate to assure compliance with applicable provisions of DHHS Performance Standards 21 CFR Sub-Chapter J, Part 1020.

Those who assemble or service beam limiting devices must follow the instructions of the original manufacturer and process the FD-2579 Assemblers Report where applicable.

You assume responsibility for compliance of this product if you fail to follow the original manufacturer's instructions or modify any component which affects radiation safety.

The FDA (CDRH) requires that manufacturers must include a specific requirement that the assembler perform all applicable tests at the time of installation. A thorough explanation of the equipment required and step-by-step instructions must be provided by the manufacturer. The instructions include a requirement to record key data to demonstrate at a later time that all tests were performed and that the equipment was left in full compliance with the standards.

As an assembler, you must perform these tests for the applicable requirements at the time of installation and following any repairs which could alter the performance.

A Compliance Data Log is provided in this manual to record the results of the tests.

1.2 BACKGROUND

An X-ray collimator functions as an apparatus for regulating the cross-sectional size and shape of a beam of radiation which emerges from an X-ray tube.

The source of radiation is virtually a point-source and, due to the tube housing design, emerges from the port as a solid diverging cone of radiation. The finite angle of the anode surface limits the X-ray beam on the anode side (heel-effect) forming a "D" shaped X-ray field, limiting the useful coverage.

In "collimating" a beam to a given size and shape, a geared-pair of lead shutters are moved symmetrically into the beam to absorb the unwanted portion of the emerging beam. A second geared-pair of shutters are positioned at right angles to the first pair, and again are moved symmetrically into the beam. In this manner a continuously variable square/rectangular beam is formed.

The landing area of the beam will contain a radiographic or fluoroscopic image receptor located in a plane perpendicular to the beam at predetermined distances from the radiation source (focal spot).

The size and shape of the image receptor will determine the maximum useful cross-sectional size and shape of the beam in the plane of the image receptor. The source-to-image receptor distance (SID) determines the actual shutter opening required to regulate the beam size and shape in the plane of the image receptor.

"Positive" beam-limiting (PBL) devices incorporate means to prevent X-ray production until the beam limitation meets the applicable provisions of the Performance Standards.

Automatic PBL devices incorporate motors that regulate the shutter opening as required. Manual PBL devices require the operator to adjust the shutters by the use of knobs, levers, etc.

The primary objective of the electronic logic circuitry is to limit the beam to the size of the image receptor and to provide other standardized operations consistent with the DHHS Performance Standards 21 CFR Sub-Chapter J. This is accomplished by electrically measuring the size of the image receptor and the distance (SID) involved. The resultant signal is then compared to a signal which represents the collimator shutter opening to form a means of limiting the beam.

1.3 LINEAR™ SERIES COLLIMATOR FEATURES

1.3.1 SERVICEABILITY

The Linear™ FSE series collimator logic provides a second objective not included with other similar products--serviceability. This new dimension is incorporated in a manner which allows an accurate pre-alignment of the collimator system prior to the production of X-rays and also serves as an aid in the diagnostic troubleshooting of the logic and collimator functions.

The use of sophisticated calibration software used in conjunction with an alphanumeric display and programming switches located on the logic board, virtually eliminates the requirement for a digital voltmeter to be used for calibrating the collimator. Instrumentation, as a rule, will only be required to pinpoint a fault identified by the indicators and programming switches and for external circuitry. Confirming radiation exposures must be made, and only with all parties located in a radiation protected area.

After confirming that the logic board and collimator are functional and calibrated, external signals can be selectively applied to check for correct operation. After all external signal sources are confirmed, the calibration switch is then set to the "RUN" position with the collimator returned to the normal operating condition.

1.4 STANDARD FEATURES (MODEL LINEAR™ FSE)

The Linear™ FSE collimation systems from Eureka include all features required for diagnostic excellence...

... Rated for operation to 150 kVp.

... 14° field coverage from central ray.

... Square or rectangular pattern continuously variable from 17" x 17" at 36" SID to fully closed. Provides approximately 14" x 14" coverage at 27 inch SID.

... High reliability solid state motor drive incorporated inside head.

... New high reliability continuous SID monitor available.

... In-port shuttering system provides improved film edge contrast.

... Microprocessor-based logic circuitry which can be located inside the spotfilm chassis simplifies interconnect wiring.

... Digital display on logic PCB assembly allows easy troubleshooting and calibration.

... Programming switches allow use of a single "RATIO" of continuous SID monitor. Ratios of 1:1, 2:1, 3:1 and 4:1 are established by switch selection to simplify ordering and stocking of mechanisms.

... Exposure Hold relay located directly on logic board provides both normally-open and normally-closed contacts.

... Quick disconnect connectors allow easy servicing and installation.

... Directly compatible with the Eureka EXT-950 (DPSC) Spotfilm Device.

1.5 SPECIFICATIONS (MODEL LINEAR™ FSE)

1.5.1 COLLIMATOR HEAD

Radiation Shielding:	Rated for 150 kVp. Less than 50 mR/hr leakage at one meter.
Film Coverage:	Square or rectangular pattern. Continuously variable from approximately 14" x 14" to closed at 27 inch SID. Proportional coverage at other SIDs.
Inherent Filtration;	1.5 mm (minimum) aluminum equivalent at 70 kVp and above.
Cycle Time:	750 milliseconds (typical) 1.5 seconds (maximum) fully open to fully closed.
Overall Dimensions:	8.188" L x 6.50" W x 8.25" H
Weight:	17.5 lbs.
Power Requirements:	24 VAC @ 1.2 amps (motor drive) + 15 VDC @ 100 mA (supplied by FSE logic assembly).

1.5.2 FSE LOGIC ASSEMBLY

Intended Operation...

Fluoroscopic:	Allows manual positioning within the PBL field size through use of external shutter controls.
Spotfilm:	Allows sizing to PBL specifications when requested by spotfilm device.
SID Range:	25.6 to 51.1 inches continuous
Repeatability:	Within 1% of SID used.
X-Ray Field Accuracy:	Within 2% of SID in use in length and width (sum less than 4%).
Exposure Interlock:	Isolated form "C" contact rated at 1 amp @ 120 VAC (resistive load).
Image Size Signal Inputs:	VIRL - Requested long image size VIRC - Requested cross image size VXFDL - Longitudinal manual shutter control input VXFDC - Cross (transverse) manual shutter control input SF RET - Signal return (common) connection for above signals
Image Size Signal Range:	0 to +5 VDC (full scale) with a 1 inch image size equal to 0.287 volts.
Signal Output:	Spotfilm Ref +10 volt reference signal (adjustable) provided to interface with customers image sizing circuitry. Must be used with SF RET signal input above.
Recommended SID Potentiometer Ohms per Inch Range:	7.8 to 39 ohms per inch
Manual Shutter Control Requirements:	One each for cross and long independent, matched within 5%.
Required Maximum Resistance:	≥ 1,000 Ω, ≤ 5,000 Ω
Wiper Travel Required:	75% of total resistance
Input Power Requirements:	24 VAC @ 1.2 amps 120 VAC @ .5 amps
Dimensions:	8.5" L x 2.75" W x 5.0" H
Weight:	1.5 lbs.

1.6 RADIATION AND MECHANICAL/ELECTRICAL WARNING (from NEMA Standards Publication/No. XR8-1979)

Radiation ☢ Warning for Diagnostic X-Ray Systems

X-rays are dangerous to both operator and others in the vicinity unless established safe exposure procedures are strictly observed.

The useful and scattered beams can produce serious, genetic or potentially fatal bodily injuries to any persons in the surrounding area if used by an unskilled operator. Adequate precautions must always be taken to avoid exposure to the useful beam, as well as to leakage radiation from within the source housing or to scattered radiation resulting from the passage of radiation through matter.

Those authorized to operate, test, participate in or supervise the operation of the equipment must be thoroughly familiar and comply completely with the currently established safe exposure factors and procedures described in publications such as Sub-Chapter J of Title 21 of the Code of Federal Regulations, *"Diagnostic X-ray Systems and their Major Components,"* and the National Council on Radiation Protection (NCRP) No. 33, *"Medical X-Ray and Gamma-Ray Protection for Energies up to 10 MeV-Equipment Design and Use,"* as revised or replaced in the future.

Failure to observe these warnings may cause serious, genetic or potentially fatal bodily injuries to the operator or those in the area.

Mechanical-Electrical ⚡ Warning for Diagnostic X-Ray Systems

All of the movable assemblies and parts of X-ray equipment should be operated with care.

Only properly trained and qualified personnel should be permitted access to any internal parts. Live electrical terminals are deadly; be sure line disconnect switches are opened and other appropriate precautions are taken before opening access doors, removing enclosure panels, or attaching accessories.

Do not remove the flexible high tension cables from the X-ray tube housing, or high tension generator, or the access covers from the generator until the main and auxiliary power supplies have been disconnected.

When disconnecting high voltage cables, they must be grounded immediately in order to dissipate any electrical charge that may remain on the cables or the tube.

Failure to comply with the foregoing may result in serious or potentially fatal bodily injuries to the operator or those in the area.

1.7 COMPATIBILITY

The Linear™ FSE series collimators are compatible and can be adapted for use with X-ray tube/housing assemblies that meet all of the following factors:

1. Focal Distance of X-ray Tube:

   The focal spot to collimator mounting flange distance must be 2.44 inches, ± 0.031 inches (1/32"). Four (4) spacers are supplied for adaptation:

   1 - 1/4 inch (0.25") spacer
   3 - 1/16 inch (0.06") spacer

   Use any combination to achieve the requirements.

2. Leakage Radiation:

   Maximum leakage radiation from the X-ray tube/housing assembly must not exceed 50 mR/hr at 100 cm (40 inches) at specified leakage technic factors.

3. Inherent Filtration and Half-Value Layer:

   EUREKA Linear™ FSE collimators have a minimum value of 1.5 mm aluminum equivalence at 100 kVp. This value plus any tube inherent filtration plus any added filtration must meet the minimum requirements of 21 CFR Sub-Chapter J, Part 1020.30 (m)(1) Table 1 on beam quality (e.g., minimum HVL at 100 kVp must be 2.7 mm Al.).

4. Application:

   The intended application is for general purpose fluoroscopic equipment. Maximum tube rating must be 150 kVp or less.

5. Installation:

   Must be made with supplied hardware including mounting flange, spacers (as required), and four (4), 1/4" x 20 bolts equally spaced on a 3.62" diameter bolt circle.

1.8 MAINTENANCE

The collimator system must be properly maintained to assure compliance with CDRH regulations and useful life.

Preventive maintenance is to be performed once every twelve months. This includes inspection and lubrication of the collimator mechanism.

Checkout should also occur if any of the following conditions occur:

Premature electronic component failure.

When collimator is removed from tube/housing assembly.

When collimator has been subjected to external damage.

Refer to Section 4.0 for collimator CHECKOUT procedure.

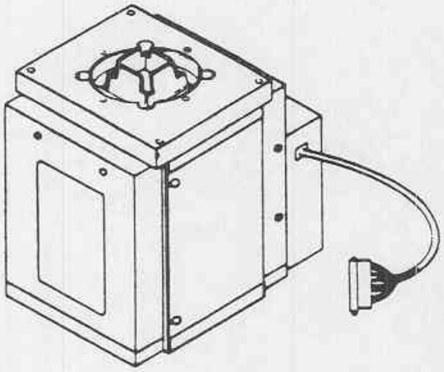
1.9 COMPLIANCE REQUIREMENTS

It is necessary for the assembler to verify compliance. A series of tests, when performed at the time of installation, will indicate compliance with 21CFR, Sub-Chapter J, Part 1020, Performance Standards. These tests which are described in Section 5, "Compliance Verification," must be performed before releasing the collimator for use. A record sheet is provided at the end of Section 5 and should be completed by the installer. In order to avoid wasted effort, the installation, checkout and adjustment procedures described in Sections 2 through 4 should be completed prior to performing the compliance tests.

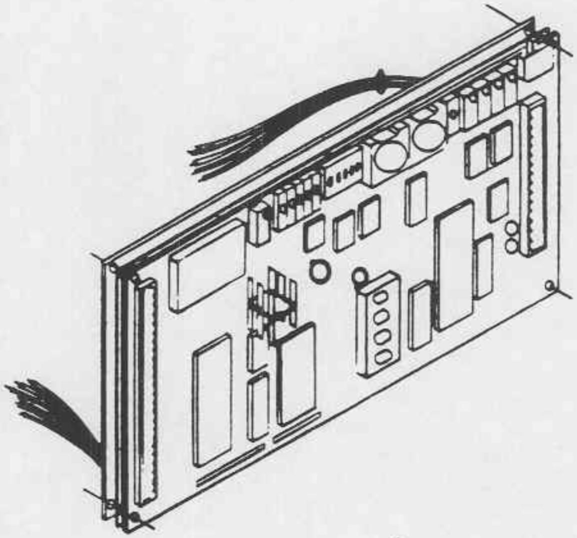
NO TEXT

SECTION 2.0

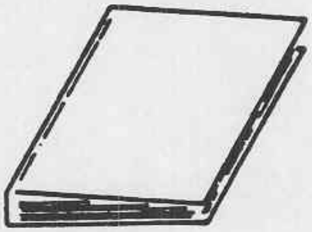
INSTALLATION



COLLIMATOR HEAD



LOGIC ASSEMBLY INSTALLED
IN EXT-950 (DPSC) SPOTFILM DEVICE



MANUAL

COMPONENT IDENTIFICATION

Figure 2.1

2.0 INSTALLATION

2.1 UNPACKING

Carefully unpack the equipment and check for damage incurred during shipment. Any damage should be referred to the agency that delivered the product. All packing material should be retained for reuse in the event that the system should require return to the factory.

2.2 EQUIPMENT SUPPLIED

Refer to Figure 2.1 for component identification.

... Linear™FSE Collimator Head
... Linear™ FSE Logic Assembly (installed in rear of EXT-950 (DPSC) Spotfilm Device)
... Installation Manual containing Assemblers Report FD-2579, Returned Goods Authorization/Service Report

2.3 COLLIMATOR MOUNTING AND INTERFACING

2.3.1 SPACING CONSIDERATIONS

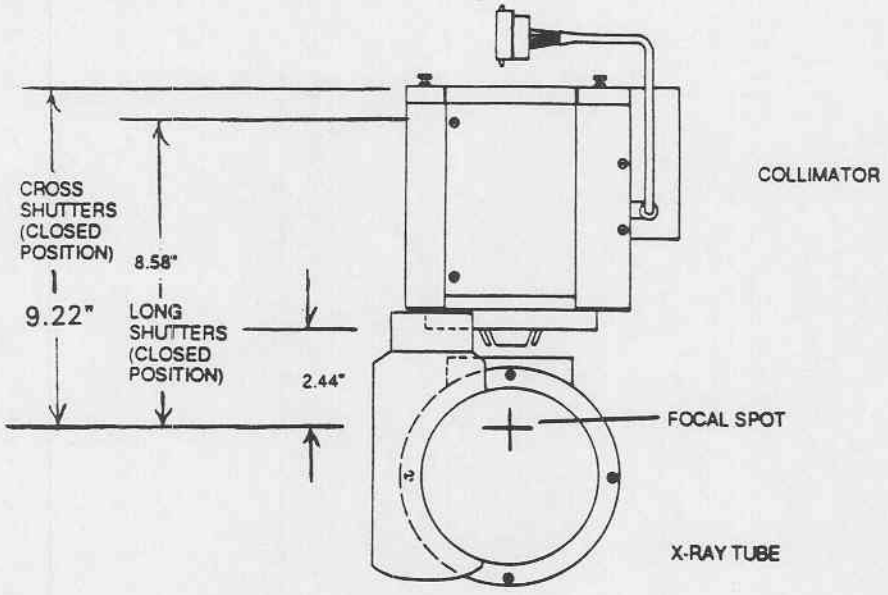
In order to properly mount the collimator head to the X-ray tube, a mounting plate, either Eureka supplied or provided by the table manufacturer, must be used. The thickness of this plate must be determined prior to attempting to mount the collimator head. From this information and that provided by the X-ray tube manufacturer, the total thickness of any required spacers can be determined. The procedure for doing this is as follows:

NOTE: The collimator will not perform properly unless the focal-spot-to-collimator mounting surface distance is 2-7/16" (2.44 inches, 62 mm) ± 1/32" (.031 inches, 1 mm). Be sure to include any permanent mounting plates in the focal-spot-to-port-boss distance stated in the tube manufacturer's data.

1. Determine the X-ray tube mounting flange (port boss) to focal spot distance from the data supplied with the X-ray tube (Do not rely on an inscribed mark on the tube housing). See Figure 2.2 for an example.

2. Add to this measurement the thickness of the mounting plate to be used.

3. Subtract the result from 2.44" to determine the thickness of the spacers (if any) required.


CROSS SHUTTERS (CLOSED POSITION)
9.22"
8.58"
LONG SHUTTERS (CLOSED POSITION)
2.44"
COLLIMATOR
FOCAL SPOT
X-RAY TUBE

COLLIMATOR TO FOCAL SPOT DISTANCE
Figure 2.2

2.3.2 COLLIMATOR AND MOUNTING PLATE ATTACHMENT

Attach the mounting plate to the X-ray tube with the screws provided. Any required spacers should be placed between the mounting plate and the X-ray tube port boss. Refer to Figure 2.3.

In order to insure a safe and secure mounting of this collimator to the X-ray tube housing, the following installation guidelines should be followed.

1. Two different lengths of screws are provided in the cloth bag containing the spacers. Determine the correct length of screw to use taking into account the collimator spacing requirements and/or peculiarities of the tube housing boss.
2. Clean the screws and housing port boss with alcohol and, if necessary, remove any debris which may be present in the tube housing mounting holes.
3. **Securely** fasten the mounting plate and spacers to the X-ray tube mounting surface. As a precaution, a medium strength thread locking compound, such as Loctite #242, should be applied to the screws before fastening the collimator mounting ring to the tube housing. The use of Nylok or vibration resistant screws is also recommended.

   Verify that the collimator mounting screws engage the housing by at least five (5) threads when used with any required collimator spacer plate(s).

4. Carefully support the collimator in place on the mounting plate, aligning the four (4) 15/64" diameter mounting holes with those on the mounting plate. Using the appropriate hardware and adherence to (3) above, securely fasten the collimator to the mounting plate. Verify that the collimator head is oriented properly with respect to shutter positioning as per Figure 2.3.

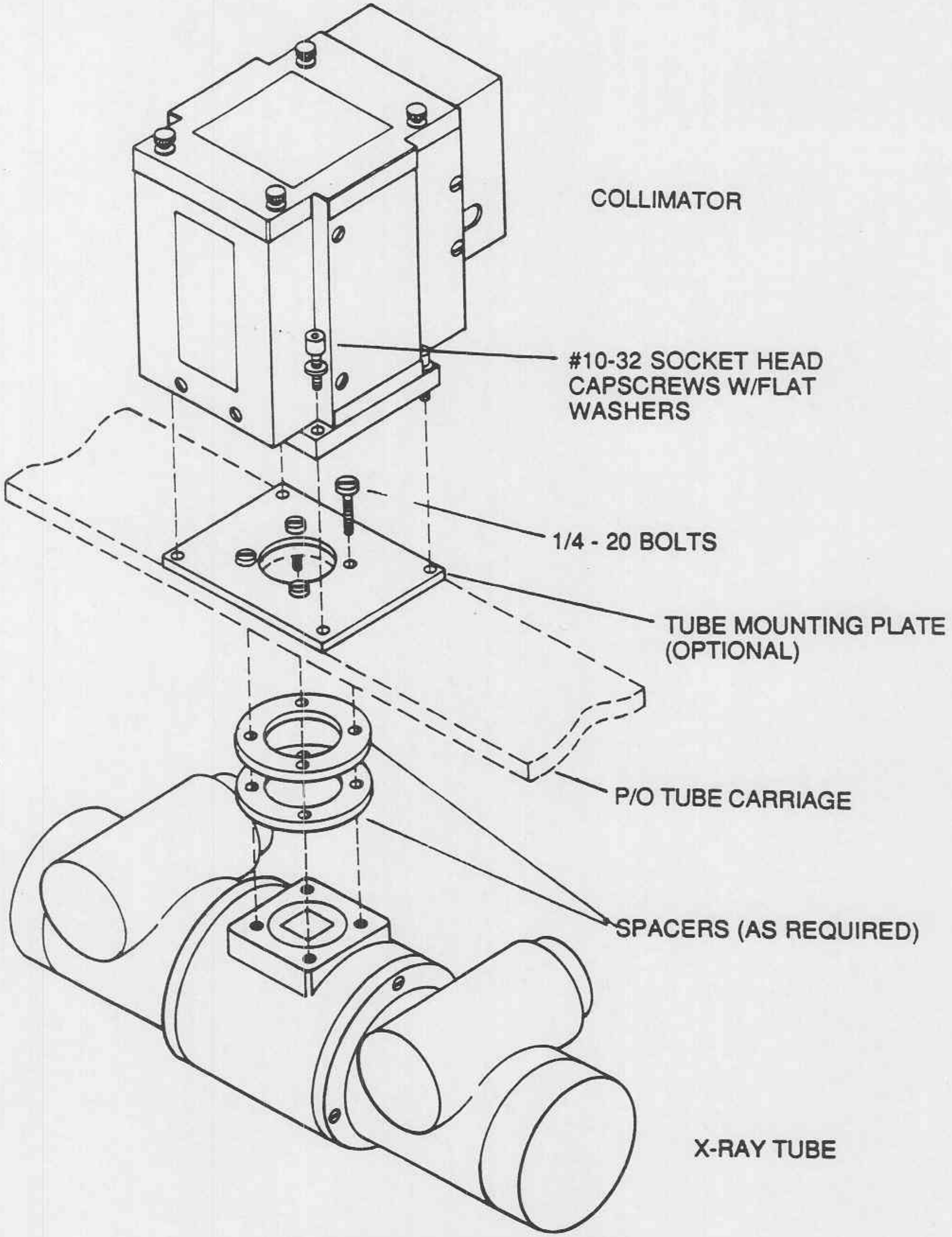
NOTE: The Linear™ FSE is designed to be used with a lead diaphragm or cone in the plastic port of the X-ray tube.

If it is found that lead diaphragms or cones require removal or modification, consult the factory.

5. After mounting the collimator and/or performing any service to it or the tube housing, inspect the fit of the collimator and tube housing. Grasp and attempt to move the collimator and then the tube housing assembly while inspecting for loose joints or gaps between the tube/collimator assembly as well as other tube mounting areas.

WARNING!

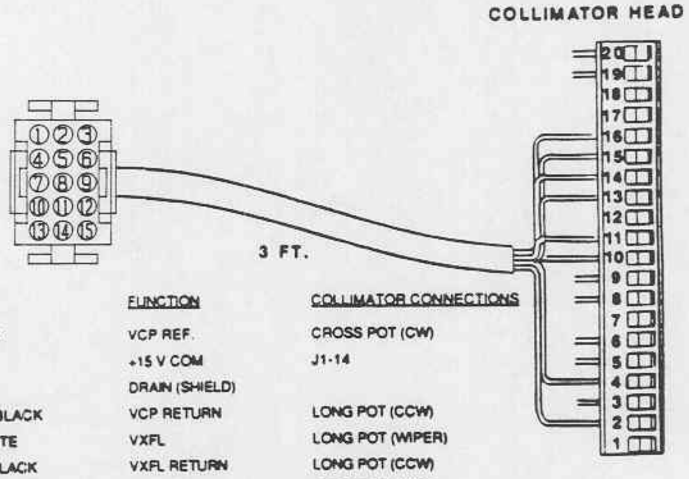
FAILURE TO ADHERE TO THE ABOVE GUIDELINES MAY RESULT IN LOOSENING, DAMAGED SCREWS OR MOUNT FAILURE WHICH COULD RESULT IN HEAVY COMPONENTS FALLING DURING USE. INCIDENTS OF LOOSE SYSTEM COMPONENTS SHOULD BE REPORTED IMMEDIATELY TO X-RAY SERVICE PERSONNEL FOR REPAIR.


COLLIMATOR
#10-32 SOCKET HEAD CAPSCREWS W/FLAT WASHERS
1/4 - 20 BOLTS
TUBE MOUNTING PLATE (OPTIONAL)
P/O TUBE CARRIAGE
SPACERS (AS REQUIRED)
X-RAY TUBE

COLLIMATOR/TUBE MOUNTING
Figure 2.3

2.3.3 INTERCONNECT CABLING

The collimator head is supplied with a 3-foot cable and plug. An additional 20-foot interconnection cable is provided to interface to the Eureka undertable logic assembly. Refer to Figure 2.4 for the pin placement wire color and function.



COLL PLUG	COLOR	FUNCTION	COLLIMATOR CONNECTIONS
1	RED/BLK	VCP REF.	CROSS POT (CW)
2	GREEN	+15 V COM	J1-14
3		DRAIN (SHIELD)	
4	GREEN/BLACK	VCP RETURN	LONG POT (CCW)
5	RED/WHITE	VXFL	LONG POT (WIPER)
6	WHITE/BLACK	VXFL RETURN	LONG POT (CCW)
7	BLACK/WHITE	VXFC RETURN	CROSS POT (CW)
8	GREEN/WHITE	VXFC	CROSS POT (WIPER)
9	RED	+ 15 VDC	J1-13
10	BLUE	LONG OPEN	J1-16
11	BLUE/BLACK	LONG CLOSE	J1-15
12	ORANGE	CROSS OPEN	J1-2
13	ORANGE/BLACK	CROSS CLOSE	J1-4
14	WHITE	24 VAC COMMON	J1-10
15	BLACK	24 VAC	J1-11
	RED		J1-1 CROSS OPEN WINDING
	BLACK		J1-3 CROSS CLOSE WINDING
	WHITE		J1-5 CROSS MOTOR COMMON
	WHITE		J1-6 CROSS MOTOR COMMON
	WHITE		J1-8 LONG MOTOR COMMON
	WHITE		J1-9 LONG MOTOR COMMON
	BLACK		J1-19 LONG OPEN WINDING
	RED		J1-20 LONG CLOSE WINDING

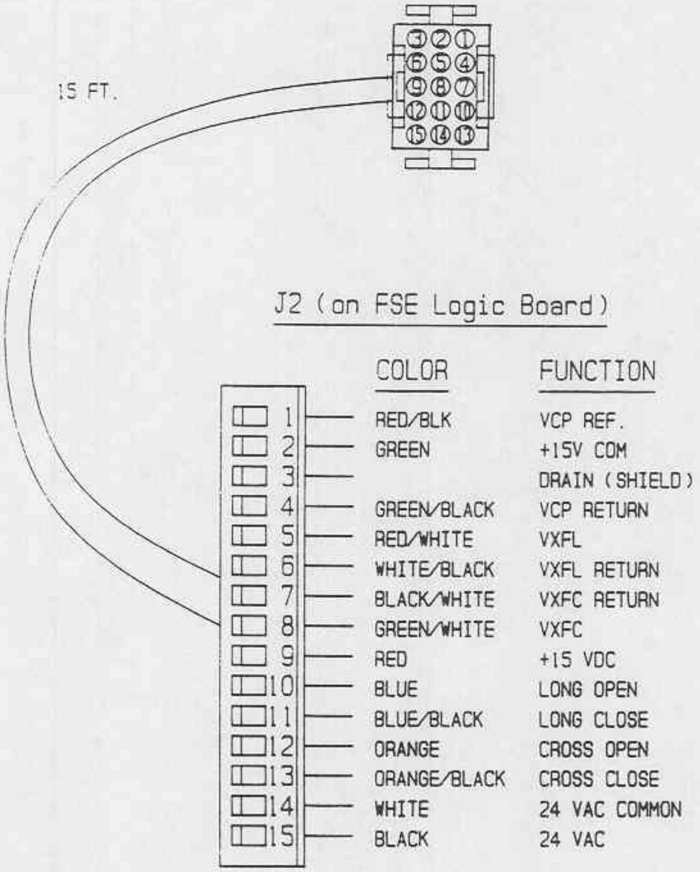
COLLIMATOR INTERCONNECT CABLING
Figure 2.4

2.3.4 COLLIMATOR HEAD TO FSE LOGIC ASSEMBLY INTERFACING

An interconnect cable, consisting of a 15-position plug which connects to the FSE logic PCB, and a 15-position plug which connects to the collimator head cable plug is provided. Refer to Figure 2.5 for the wiring diagram showing wire colors and terminal connections.

The following items should be considered before interfacing:

1. Avoid sharp bends or kinks in the cabling. These may result in reduced cable life and erratic operation.
2. Move the entire tube/carriage/tower to its extremes to verify that no part of the mechanism interferes with the cabling.
3. Avoid routing the cabling near sources of high radio or magnetic interference such as table tilt motors, carriage locks, etc.
4. Do not overtighten strain reliefs or wire ties to the extent that they deform the PVC jacket on the cable.



J2 (on FSE Logic Board)

	COLOR	FUNCTION
1	RED/BLK	VCP REF.
2	GREEN	+15V COM
3		DRAIN (SHIELD)
4	GREEN/BLACK	VCP RETURN
5	RED/WHITE	VXFL
6	WHITE/BLACK	VXFL RETURN
7	BLACK/WHITE	VXFC RETURN
8	GREEN/WHITE	VXFC
9	RED	+15 VDC
10	BLUE	LONG OPEN
11	BLUE/BLACK	LONG CLOSE
12	ORANGE	CROSS OPEN
13	ORANGE/BLACK	CROSS CLOSE
14	WHITE	24 VAC COMMON
15	BLACK	24 VAC

J2 LOGIC WIRING
Figure 2.5

2.4 LOGIC ASSEMBLY INTERFACING

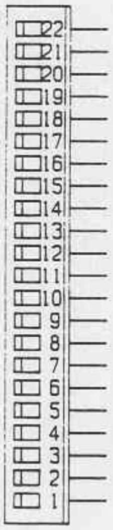
2.4.1 EXT-950 (DPSC) SPOTFILM DEVICE INTERFACING

Refer to Figure 2.6 and make the following connections between the FSE logic assembly and the EXT-950 (DPSC) Spotfilm Device:

EXT-950 (DPSC) Interface PCB	**Control Function**	**FSE Logic Assembly**
J9-16	**VIRL**	J1-9
J9-15	**VIRC**	J1-7
J9-17	**VXFDL**	J1-11
J9-18	**VXFDC**	J1-10
J9-13	**S.F. REF**	J1-17
J9-14	**COM**	J1-14
Terminal Block		
TS1-3	**110 Line (BLK)**	
TS1-2	**110 Neutral (WHT)**	
TS1-1	**Ground (GRN)**	
Power Cable*		
Purple Lead	**24 VAC (PURPLE)**	
Brown Lead	**24 VAC (BRN)**	

***Butt Splice Required**

J1 (on FSE Logic Board)



	COLOR	FUNCTION
22	*	EXP. RELAY N.O.
21	*	EXP. RELAY COMMON
20	*	EXP. RELAY N.C.
19	BLUE	+15 VDC
18	**	CONT. SID
17	*	S.F. REFERENCE (10 VDC TO SFD)
16	*	LOGIC BOARD COMMON
15	*	SHIELD (TO SFD)
14	*	
13	GREY	+15 VDC COMMON
12	*	-15 VDC COMMON
11	*	VXFDL (TO SFD)
10	*	VXFDC (TO SFD)
9	*	VIRL (TO SFD)
8	ORANGE	-15 VDC
7	*	VIRC (TO SFD)
6	*	+5 VDC REFERENCE
5	**	CONT. SID RETURN
4	VIOLET	24 VAC FILTERED
3		24 VAC FILTERED
2	BROWN	24 VAC COMMON
1		24 VAC COMMON

+ 15 VDC Power Supply and Line Filter

GREEN	15 VDC POWER SUPPLY GROUND
GREEN	LINE GROUND
BLACK	120 VAC INPUT
WHITE	120 VAC INPUT
VIOLET	24 VAC (FROM OPT. POWER SUPPLY)
BROWN	24 VAC (FROM OPT. POWER SUPPLY)

*	Indicates customer connections
**	Connections for optional continuous SID monitor

J1 LOGIC WIRING
Figure 2.6

2.5 SID MONITOR POTENTIOMETER ADJUSTMENT

With power to the collimator system off, disconnect the red and black wires of the SID monitor interconnection cable from terminal strip locations J1-18 and J1-5 on the Linear™ FSE logic PCB.

Connect the leads of a digital ohmmeter to the red and black wires. Vary the SID of the imaging system and observe that as SID decreases, the SID potentiometer resistance decreases. If a decrease in SID does not produce a decrease in resistance, then remove the buss wire on the SID pot from the red wire and connect it to the black wire.

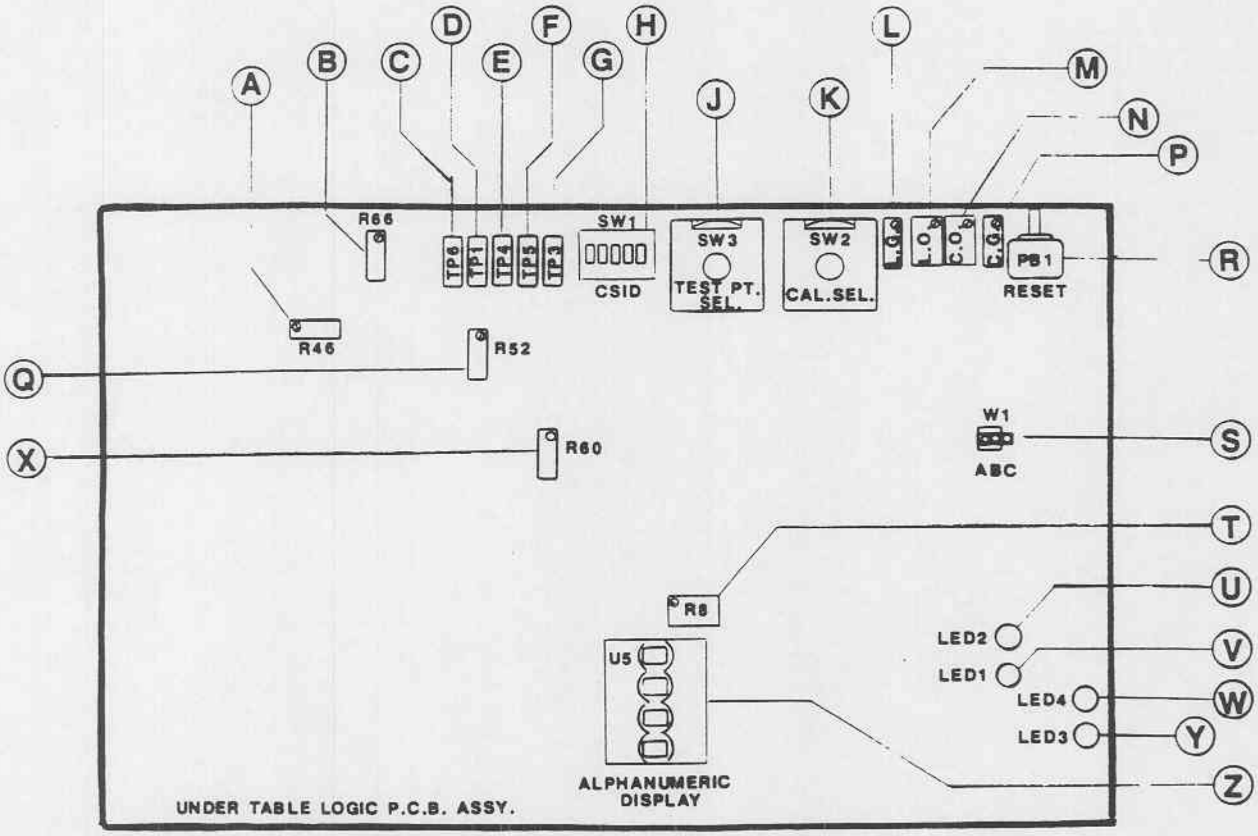
Set the SID of the SFD to its minimum design operating range. Adjust the SID monitor cable so that the SID monitor resistance will be 40 ± 10 ohms when properly attached to the cable clamp.

NOTE: If the specified resistance is not obtainable, it may be necessary to relocate the cable clamp, attach additional cable, or readjust the SID potentiometer by loosening the setscrew attaching the flexible coupling to the pot shaft. Re-tighten the setscrew.

Reconnect the SID monitor interconnection cable as shown in Figure 2.6. Make sure all cable clamps are properly tightened.

SECTION 3.0

CALIBRATION


A
B
C
D
E
F
G
H
J
K
L
M
N
P
R
R66
TP6
TP1
TP4
TP5
TP3
SW1
CSID
SW3
TEST PT. SEL.
SW2
CAL.SEL.
L.G.
L.O.
C.O.
C.G.
PS1
RESET
R46
R52
Q
X
R60
W1
ABC
S
T
R8
U
LED2
LED1
V
LED4
W
LED3
Y
U5
ALPHANUMERIC DISPLAY
Z
UNDER TABLE LOGIC P.C.B. ASSY.

Logic Board Calibration

Figure 3.1

3.0 CALIBRATION

The following procedure provides the information necessary to properly maintain and calibrate the undertable collimation system used with the spotfilm device.

3.1 GENERAL DESCRIPTION

3.1.1 The undertable collimation system consists of the undertable collimator head which is attached to the undertable tube located beneath the X-ray tabletop and an undertable logic PCB assembly located inside the spotfilm device at the rear of the chassis. A single 15-conductor cable is used to interconnect the two parts of the system.

3.1.2 The undertable collimator head is comprised of two pairs of motor-driven lead shutters which allow stepless adjustment of the X-ray field into a square or rectangular pattern. Two feedback potentiometers, one for each shutter pair, are attached to the shutter mechanisms by gears and provide a signal proportional to the shutter opening. These signals are then passed on to the undertable logic PCB for processing.

3.1.3 The undertable logic PCB provides the control logic necessary to adjust the collimator head shutters to the format requested by the spotfilm device over the possible SID range. In order to accomplish this the undertable logic PCB assembly requires the following input signals:

VIRL	Voltage proportional to the requested format size in the longitudinal (head-foot) direction.
VIRC	Voltage proportional to the requested format size in the transverse (cross-table) direction.
VXFDL	Voltage set by the front panel shutter control knob in the longitudinal direction.
VXFDC	Voltage set by the front panel shutter control knob in the transverse direction.
VSID	Voltage proportional to the source-to-image distance of the undertable tube to the spotfilm device.
VXFL	Voltage proportional to the position of the longitudinal shutter.
VXFC	Voltage proportional to the position of the transverse shutter.

All of the above analog signals are in the 0 to +5 volt range.

3.2 SERVICE ADJUSTMENTS, CONTROLS AND INDICATORS

3.2.1 Following is a description of all adjustments, controls and indicators used in the calibration of the undertable logic PCB. Refer to Figure 3.1 for their exact location on the PCB assembly.

3.2.2 TEST POINTS AND FUNCTION

Test Point Name	Item Number	Function
TPI-COM	D	Provides a common or ground test point for use with an external digital multimeter.
TP2	--	Not present on this PCB assembly version.
TP3-+5V A/D	G	Used in conjunction with TPI to monitor and adjust the analog-to-digital converter reference voltage.
TP4-mA+	E	Used in conjunction with TP5-mA- to monitor and calibrate the continuous SID monitor current. Must be used with a digital D.C. ammeter with a 0 to 10 mA current range.
TP5-mA-	F	See TP4-mA+ above.
TP6-MUX	C	Used in conjunction with TP1-COM and the analog voltage channel select switch to monitor, using a digital voltmeter, all other analog voltage inputs and references.

3.2.3 ANALOG VOLTAGE CHANNEL SWITCH

The analog voltage channel switch SW3, Item J, is used in conjunction with the TP1-COM and TP6-MUX test points to provide a convenient means of monitoring the analog voltages used by the collimator system without having to move test probes of an external digital voltmeter.

Following is a list of SW3 switch positions and the voltages they monitor:

SW3-Position #	Signal Name	Description
0	VSID IN	Voltage proportional to the source-to-image distance.
1	VIRL IN	Voltage proportional to the requested format size in the longitudinal direction.
2	VIRC IN	Voltage proportional to the requested format size in the transverse direction.
3	VXFDL IN	Voltage proportional to the front panel shutter control position for the longitudinal direction.

SW3-Position #	Signal Name	Description
4	VXFDC IN	Voltage proportional to the front panel shutter control position for the transverse direction.
5	VXFL IN	Voltage proportional to the collimator head shutter position in the longitudinal direction.
6	VXFC IN	Voltage proportional to the collimator head shutter position in the transverse direction.
7	N.C.	No connection - reserved for future use.
8	S.F. Ref.	Reference voltage provided to the spotfilm device interface PCB adjustment pots.
9	VCP Ref.	Reference voltage provided to the collimator head shutter potentiometers.

3.2.4 CALIBRATION/MODE SWITCH AND ALPHANUMERIC DISPLAY

3.2.4.1 The calibration/mode switch SW2, Item K, is used with the alphanumeric display module U5, Item Z, to provide information regarding the performance of the system as well as for a convenient means to calibrate the undertable collimator system. Three basic operating modes can be selected depending on the position of switch SW2. Following is a list describing the possible modes and their function:

3.2.4.2 RUN MODE - SW2 POSITION 0

With switch SW2 in position 0, the collimator is placed in the RUN mode with the message "RUN" appearing on the alphanumeric display. This is the normal operating mode for the collimator system. This mode will allow the collimator logic to properly position the collimator head shutters upon the command of the spotfilm device. This mode also enables the error detection software of the undertable logic PCB.

If a system error is encountered during operation of the collimator logic, the message "ERR1" will be displayed in the alphanumeric display. This message typically indicates that the collimator shutters were incapable of driving to their proper position within a time period of approximately 4 seconds. Possible causes for this can be blockage of the shutter mechanism, broken signal leads or improper calibration. The error code is displayed for 5 seconds, at which time the collimator will again try to adjust itself to the proper position.

NOTE: Upon completion of the calibration procedure, the calibration switch, SW2, must be placed in Position 0, RUN, in order for the collimating system to perform properly.

3.2.4.3 CYCLE MODE - SW2 POSITION 1

With switch SW2 in Position 1, the collimator is placed in the cycle mode with the message "CYC" appearing on the alphanumeric display. In this mode the collimator logic will periodically open and close the collimator head shutters while at the same time indicating on the alphanumeric display which shutter operation the logic is attempting.

This function is useful in verifying the proper operation of the shutter drive system and also allows an automatic "Burn In" test of the system prior to its release for service. A typical operating sequence is as follows:

Upon placing SW2 in Position 1, the message "CYC" is displayed for 2 seconds.

The message "CLC" is then displayed. At this time, the collimator shutters should both close to their minimum opening.

The message "LOPN" is then displayed. At this time the longitudinal shutters will open.

The message "COPN" is then displayed. At this time the transverse shutters will open.

The message "LCLS" is then displayed. At this time the longitudinal shutters will close.

The message "CCLS" is then displayed. At this time the transverse shutters will close.

The message "CYC" will again be displayed for 40 seconds at which time the above cycle will repeat itself.

NOTE: If the collimator system is unable to perform the actions as described above during the cycle operation, the error message "ERR1" will be displayed indicating a fault. The system will then attempt to recycle. Any error code occurring during this mode should be corrected before release of the system.

NOTE: The cycle mode should be exited by placing SW2 to Position 0, RUN mode, prior to release of the system for use.

3.2.4.4 CALIBRATION MODE - SW2 POSITION 9

With switch SW2 in Position 9, the collimator is placed in the calibration mode with the message "CAL0" appearing on the alphanumeric display. In this mode the positions of SW2 will take on secondary functions which allow the displaying of the digital value in A/D units of all the analog input channels to the undertable logic system.

NOTE: While in the calibration mode or any of its secondary functions, no movement of the collimator shutters will take place. However, real time changes to the analog channel being displayed will be indicated on the alphanumeric display. In order to verify the effect of an adjustment made while in the calibration mode the system must be placed in the "RUN" mode, SW2 Position 0.

NOTE: A/D units refers to the digital conversion of the analog signal being displayed. The undertable collimator system uses a 10 bit A/D converter which allows decimal numbers in the range 0 to 1023 inclusive to be displayed. Since the A/D converter uses a 5.00 volt full scale reference 1 A/D unit is equivalent to 5 volts/1023 or .00488 volts.

Following is a list of the calibration mode switch positions and their functions:

NOTE: Prior to display of the numeric information for the selected position of SW2, a alphanumeric message will appear for two seconds indicating the channel function.

SW2-Position	Alphanumeric Msg.	Function
9	CAL0	Indicates that the calibration mode has been selected. If switch SW2 is left in Position 9, the display will indicate the SID in inches.
9	SIDI	The display will indicate the SID in inches. Up and down movement of the SFD will be reflected on the display.
8	GND	Displays the value of analog GND. A value other than zero indicates a possible fault in the analog MUX and A/D converter circuitry.
7	VXFC	Displays the current value of the transverse (cross) collimator head shutters. Moving the collimator head shutter by hand will result in a change of this display.
6	VXFL	Displays the current value of the longitudinal (long) collimator head shutters. Moving the collimator head shutters by hand will result in a change of this display.
5	VFDC	Displays the current value of the transverse shutter control on the SFD front panel. Moving the shutter control up and down will result in a change of this display.

SW2-Position	Alphanumeric Msg.	Function
4	VFDL	Displays the current value of the longitudinal shutter control on the SFD front panel. Moving the shutter control up and down will result in a change of this display.
0	RUN	Returns collimator logic to the RUN mode.
3	VIRC	Displays the current value of the requested image size in the transverse direction. In the fluoro mode this is the size of the image intensifier. When a radiographic exposure is requested by the SFD this display will change to the selected spotfilm format.
2	VIRL	Displays the current value of the requested image size in the longitudinal direction. Will react in the same manner as VIRC above.
1	SID	Displays the current value of SID in A/D units.

3.2.5 SID RATIO AND CALIBRATION SWITCH

The SID ratio and calibration switch, SW1, Item H, is used to adapt the SID calibration circuitry to telescoping and non-telescoping imaging systems while at the same time providing a convenient means of calibrating the SID constant current source circuitry without having to remove any hard-wired connections.

Listed below are SID calibration switch settings and their functions.

SW1-Position	Function Name	Description
1	mA CAL	Normally ON. Used in conjunction with test points TP4, mA+, and TP5, mA-. Will route the SID constant current source through a digital D.C. ammeter connected to the test points when placed in the OFF position. Must be placed back in the ON position after calibration is complete.
2	4:1	Normally OFF. Configures the SID circuitry to a 4:1 telescoping image system.
3	3:1	Normally OFF. Configures the SID circuitry to a 3:1 telescoping image system.
4	2:1	Normally OFF. Configures the SID circuitry to a 2:1 telescoping image system.
5	1:1	Normally ON. Configures the SFD circuitry to a 1:1 non-telescoping image system.

NOTE: The factory default settings are SW1-1 and SW1-5 ON with all other switches OFF. Only one ratio select switch should ever be in the ON position.

3.2.6 RESET SWITCH

The reset switch PBI, Item R, operates in conjunction with the watchdog timer shunt described below in order to provide a means of resetting the collimator microprocessor without having to go through a power-down power-up cycle for the rest of the equipment.

3.2.7 WATCHDOG TIMER SHUNT

The watchdog timer shunt W1, Item 5, is used to enable or disable the watchdog timer circuitry and reset switch PB1. The factory default placement of this shunt is between pins W1-A and W1-B enabling the watchdog timer. Listed below are the effects of placing the shunt between its two possible positions.

W1 Shunt Location	Function
A-B	Enables watchdog timer. Enables reset switch PB1. Will reset system automatically if power supplies are not within tolerance.
B-C	Disables watchdog timer. Disables reset switch PB1. To reset system, power must be removed and then applied.

NOTE: The shunt must be placed in one of the above locations in order for the collimator logic to function.

3.2.8 +5 VOLT A/D REFERENCE ADJUSTMENT

The +5 volt A/D reference adjustment R8, Item T, is used to adjust the full scale reference voltage for the analog-to-digital converter. It is factory set at +5.00 volts and should only require verification.

3.2.9 SPOTFILM REFERENCE VOLTAGE ADJUSTMENT

The spotfilm reference adjustment R46, Item A, is used to adjust the reference voltage applied to SFD interface PCB format size potentiometers. It is factory set at 10.000 volts and should only require verification.

3.2.10 COLLIMATOR POTENTIOMETER REFERENCE (VCP) ADJUSTMENT

The VCP reference adjustment R60, Item X, is used to adjust the reference voltage applied to the collimator head potentiometers. It is factory set at 10.012 volts and should only require verification.

3.2.11 CONTINUOUS SID MONITOR ADJUSTMENTS

The continuous SID monitor requires two adjustments, CSID slope ADJ., R52, Item Q, and CSID base ADJ. R66, Item B. In order to properly calibrate it to the image system being used, a constant current source of 6.99 mA, adjusted by means of R52, is connected to the SID potentiometer on the spotfilm tower. The CSID BASE ADJ. Potentiometer R66 allows the user to offset the SID voltage up or down in order to compensate for the resistance of the SID potentiometer when at its minimum value.

3.2.12 COLLIMATOR SHUTTER CALIBRATION ADJUSTMENTS

In order to calibrate the collimator head to the logic PCB assembly, two adjustments for each shutter pair are provided.

Following is a list of the adjustments and their function:

Adjustment	Item #	Name	Function
R37	L	L.G.	Adjusts gain of longitudinal shutter channel.
R38	M	L.O.	Adjusts offset of longitudinal shutter channel.
R41	P	C.G.	Adjusts gain of transverse shutter channel.
R42	N	C.O.	Adjusts offset of transverse shutter channel.

3.2.13 SHUTTER DRIVE INDICATORS

Four LED indicators are provided on the logic PCB to indicate the status of the collimator head shutter drive signals. An LED "ON" indicates that the function described below is taking place:

LED Indicator	Item #	Function
LED 1	V	Indicates a CLOSE command given to the transverse shutter.
LED 2	U	Indicates an OPEN command given to the transverse shutter.
LED 3	Y	Indicates a CLOSE command given to the longitudinal shutter.
LED 4	W	Indicates an OPEN command given to the longitudinal shutter.

3.3 +5.0 VOLT A/D REFERENCE CALIBRATION

Connect the negative lead of a digital voltmeter to TP1. Connect the other lead to TP3. Verify a voltage of +5.00 ± .01 VDC. If necessary, adjust R8 until this value is obtained.

3.4 SPOTFILM REFERENCE VOLTAGE CALIBRATION

Connect the DVM positive lead to TP6 with the negative lead on TP1. Rotate the analog voltage channel switch, SW3, to Position 8. Verify a voltage of +10.00 ± .05 volts D.C. If necessary, adjust R46 until this value is obtained.

3.5 COLLIMATOR HEAD REFERENCE VOLTAGE CALIBRATION

With the DVM connected as per 3.4 above, rotate the analog voltage channel switch, SW3, to Position 9. Verify a voltage of +10.18 ± .05 volts D.C. If necessary, adjust R60 until this value is obtained.

3.6 CONTINUOUS SID ADJUSTMENT

3.6.1 Prior to adjustment, remove any mechanical stops (e.g., myelographic) which would prevent the spotfilm device from travelling its full vertical movement.

3.6.2 If connecting the undertable logic PCB to a SID potentiometer other than that provided by the Eureka continuous SID monitor, then the resistance per inch of SID will have to be determined in order to properly calibrate the system.

Disconnect the SID potentiometer from J1-18 and J1-5 on the undertable logic PCB.

Lower the SFD to its minimum SID.

Using a digital ohmmeter, verify and adjust if necessary for a minimum SID resistance of 50 ± 10 ohms. Record this value as R_0.

Select a reference point on the SFD and measure the distance to the tabletop or focal spot. Record this value as SID_0.

Raise the SFD to its maximum SID. Record the resistance on the digital ohmmeter as R_1.

Measure the distance using the same reference points as before. Record this new distance as SID_1.

Calculate the resistance per inch using the following formula.

$$\frac{R_1\text{-}R_0}{SID_1\text{-}SID_0} = \text{Resistance per inch} = R/\text{in}$$

Example:

SID_0 = 15 inches (to tabletop)
$R_0 = 50\ \Omega$ (SID pot res. min.)
SID_1 = 32 inches (to tabletop)
$R_1 = 400\ \Omega$ (SID pot res. max.)

$$\text{Resistance per inch} = \frac{R_1\text{-}R_0}{SID_1\text{-}SID_0} = \frac{400\ \Omega - 50\ \Omega}{32\ \text{in} - 15\ \text{in}} = \frac{350\ \Omega}{17\ \text{in}} = 22.6\ \Omega/\text{in}.$$

3.6.3 In order to determine the value of the continuous SID constant current source, Table 3-1may be used or it may be calculated from the following formula.

$$\frac{.09765\ \text{V/in}}{\text{ohms/in}^*} = \text{constant current}$$

*Determined from previous step.

Example:

$$\frac{.09765\ \text{V/in}}{1.5\ \text{ohms/in}} = 6.5\ \text{mA}$$

The table below shows typical current values for various SID pot resistance changes.

SID Pot Ohms/in	Constant Current (mA)
10	9.76
14.28*	6.83
15.00	6.51
20.00	4.88
25.00	3.90
30.00	3.25

CURRENT VS. SID IN OHMS/In
Table 3-1

*Ohms/in of Eureka continuous SID monitor.

3.6.4 Reconnect the SID pot to J1-18 and J1-5 on the undertable logic PCB.

Lower the SFD to its minimum SID.

Connect a D.C. ammeter to TP4 (mA+) and TP5 (mA-) on the undertable logic PCB.

With power to the system on, place SW1-1, mA CAL, switch on the undertable logic PCB to the open, "OFF," position.

Adjust R52, CSID slope, for the current value determined from the previous section. If using the Eureka continuous SID monitor, this value is 6.83 mA.

Place SW1-1, mA CAL, to the closed, "ON," position and remove the D.C. ammeter leads.

3.6.5 Set the CAL/mode switch SW2 to Position 9. The word "CAL0" followed by the word "SIDI" will be displayed. After two seconds, the SID in inches will be displayed.

With the tabletop removed, measure the SID from the focal spot of the X-ray tube to the film plane of the SFD while it is at minimum SID.

NOTE: Do not rely on a mark inscribed on the tube housing for focal spot distance. Refer to the manufacturer's data sheet for the X-ray tube you are using.

Adjust R66, VSID Base ADJ., until the value on the display corresponds to the measured SID.

3.6.6 Raise the spotfilm device to its maximum SID and again measure the SID. The value obtained should correspond to the value indicated on the alphanumeric display.

If it is not within ± 0.3 inch of the measured value, slight readjustments to the SID current and base adjustments should be made. Repeat Steps 3.6.4 and 3.6.6 until proper tracking is obtained.

3.6.7 Return SW2 to Position 0 "RUN," and verify proper SID tracking by taking X-ray films at minimum and maximum SIDs.

3.7 COLLIMATOR SHUTTER CALIBRATION

3.7.1 DESCRIPTION

These adjustments must be performed in the event of collimator head or logic assembly replacement or whenever the installer encounters difficulty obtaining a square field size on formats such as 1-on-1 or 4-on-1. The collimator head and logic assembly are calibrated as a pair at the factory and this procedure normally is not required.

NOTE: The installer should review the procedures in Section 3 and Section 4 before performing these adjustments since re-calibration of the shutter mechanism may require a re-adjustment of the potentiometers on the spotfilm interface board. These are used to set the field size for a particular format. Refer to Section 4.0.

☢ ***WARNING*** ☢

It is necessary to make exposures in the procedure that follows. Therefore, take all precautions needed to protect personnel against unnecessary radiation.

3.7.2 COLLIMATOR SHUTTER ACCESS

Slide back the table top to gain access to the x-ray tube and collimator. Remove the four (4) knurled screws holding the collimator top cover and aluminum filter plate. Remove the cover and plate to gain access to the collimator shutters.

3.7.3 SHUTTER OFFSET ADJUSTMENT

Set CAL/MODE switch, SW2, to position 7. The word "CAL0" followed by the word "VXFC" will be displayed. After two seconds the value of the voltage in A/D units proportional to the position of the transverse shutter will be displayed.

Place fingers on each side of the transverse (farthest from the x-ray tube) shutter. Slowly and without excessive force close the shutters together. Observe the value on the calibration display. Adjust cross offset potentiometer (C.O.), R42 (Item N) on the logic assembly for a reading of 2±1.

Slowly open the transverse shutter and observe that the numbers on the calibration display increase and that fully closing the blades results in a return to the offset value obtained using R42.

Set the CAL/MODE switch SW2 to position 6. The word "VXFL" will be displayed followed by the value of the voltage in A/D units proportional to the position of the longitudinal shutter.

Slowly close the longitudinal (closest to the x-ray tube) shutters together. Adjust the longitudinal offset potentiometer (C.O.), R38 (Item M), for a value of 2±1 on the calibration display.

Slowly open the longitudinal shutters and observe that the numbers on the calibration display increase in value, while returning the blades to the closed position results in a return to the offset value obtained using R38.

3.7.4 SHUTTER GAIN ADJUSTMENT

With the U.T. logic assembly still in CAL MODE, adjust the longitudinal and transverse shutters to a half open position using fingers.

Set the spot device to an SID of 36" inches.

Insert an unexposed film cassette into the spot device and place in the PARK position. Select a 1-on-1 format and make a radiographic exposure.

NOTE: The collimator blades should not move while in the CAL MODE.

Develop the film and using a ruler measure the image. Determine whether the shutters are above or below 9.0" in size. Move the appropriate shutter a small amount and continue making exposures until the image size is 9.0" x 9.0" or as close as possible while still obtaining a square image.

Set CAL MODE switch, SW2, to position 6. Adjust the longitudinal gain pot (L6), R37 (Item L), for a value of 530±2 on the calibration display.

Set CAL/MODE switch, SW2, to position 7. Adjust the transverse gain pot (C.G.), R41 (Item P), for a value of 530±2 on the calibration display.

Place the CAL/MODE switch, SW2, to position Ø. The word "RUN" should be displayed.

Perform the operational checkout procedure in Section 4.0 to verify that a square image is obtaining and is within the dimensions specified.

3.7.5 RE-ASSEMBLY

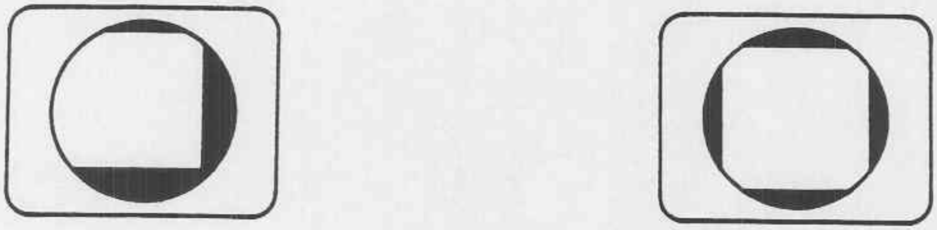
Reattach the aluminum filter plate and collimator top cover. Fasten securely using the four (4) knurled screws. Return the tabletop to its proper position.

NO TEXT

SECTION 4.0

OPERATIONAL CHECKOUT PROCEDURE

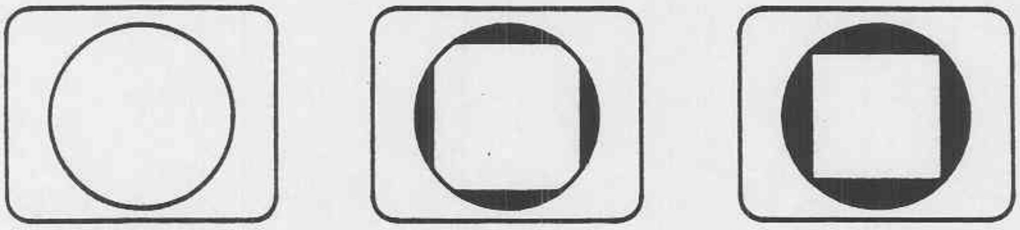
COLLIMATOR CENTERING



MIS-ADJUSTED **PROPERLY ADJUSTED**

COLLIMATOR CENTERING
Figure 4.1

FLUOROSCOPIC I.R. SHUTTER ALIGNMENT



IMPROPER **PROPER** **IMPROPER**

FLUOROSCOPIC I.R. SHUTTER ALIGNMENT
Figure 4.2

4.0 OPERATIONAL CHECKOUT PROCEDURE

4.1 DESCRIPTION

The following procedures require the alignment of the tube/collimator with the SFD and image intensifier be performed and verified as per Section 4.2 below. If after performing this step it becomes evident that the collimator shutters are still not evenly shown on the edges of the fluoroscopic image, this procedure should be stopped. The installer should then refer to the alignment procedure in the technical manual for the x-ray table to correct the problem.

Should difficulty arise in obtaining the desired results of this procedure or if maintenance has been performed on the table/tower assembly, the undertable logic PCB calibration procedure described in Section 3.0 should be performed.

NOTE: The "RUN" mode must be selected on the undertable logic PCB while performing this procedure. Refer to Section 3.0 for more information.

> ☢ ***WARNING*** ☢
>
> **It is necessary to make exposures in the procedure that follows. Therefore, take all precautions needed to protect personnel against unnecessary radiation.**

NOTE: The potentiometer adjustments referred to in Sections 4.3 through 4.10 are those found in the Eureka EXT-950 (DPSC) Spotfilm Device.

4.2 COLLIMATOR CENTERING ALIGNMENT

Loosen the four collimator mounting screws. Activate a very low level fluoro exposure (i.e., .5 mA @ 50 kVp) and adjust the shutter controls to just display the four shutter blades on the fluoro image. Determine the direction of movement required and shift the collimator **(without X-ray)** to center all four shutters on the image. Refer to Figure 4.1.

Tighten the four mounting screws.

NOTE: Some tube carriages provide additional centering adjustments than those mentioned here. Refer to the table manufacturer's manual for any additional adjustments which may be required.

4.3 FLUOROSCOPIC IMAGE SIZE (I.I.) ADJUSTMENT

Select the fluoro mode on the generator and open the collimator shutter blades to their maximum using the shutter controls on the SFD.

4.3.1 LOWER THE SFD TO ITS MINIMUM SID

Depress the X-ray switch on the SFD and observe the fluoroscopic image. The collimator blades should be evenly visible at the edges of the display. If they are not, adjust "NORM" potentiometer, R18, on the SFD Interface Board until they are.

NOTE: If unable to obtain a square image on the image tube, the collimator shutter calibration procedure in Section 3.7 may need to be performed or leveling of the I.I./Spot Device may need to be checked.

4.3.2 Vary the SID of the SFD while observing the fluoroscopic image. Verify that the image size remains the same as in Step 4.3.1 and that all collimator blades are visible.

4.3.3 Close the collimator shutter blades to their minimum using the shutter controls on the SFD. Verify that a small square or slightly rectangular image is displayed. If it is not, adjust "COLL MIN" potentiometer, R22, on the SFD Interface Board until the desired image is obtained.

4.4 1-ON-1 (FULL) FILM ADJUSTMENT

4.4.1 LOWER THE SFD TO ITS MINIMUM SID

Select the radiographic mode on the generator. Load an unexposed cassette into the SFD and place the film in the PARK position. Open the shutter blades to their maximum open position and select the 1-ON-1 format.

4.4.2 Make a radiographic exposure and develop the film. Measure the exposed area and verify that it is between 9.25" x 9.25" and 9.0" x 9.0" in size. If it is not, adjust "FULL" potentiometer, R14, on the SFD Interface Board to increase or decrease the exposed area as required.

4.4.3 Repeat this procedure until the exposed area is within the limits described in Step 4.4.2.

4.5 2-ON-1 LONGITUDINAL FILM ADJUSTMENT

4.5.1 With the SFD at minimum SID and the radiographic mode selected on the generator, insert an unexposed film cassette and advance it to the PARK position. The collimator blades should be set to their maximum open position.

4.5.2 Select the 2-ON-1 longitudinal format and make two radiographic exposures. Develop the film and measure the exposed areas. The dimensions of each exposure should be between 9.25" x 4.625" and 9.0" x 4.5" with no more than 3/16" gap or overlap between the images. If it is not, adjust "HALF" potentiometer, R15, on the SFD Interface Board to increase or decrease the exposed area as required.

4.4.3 Repeat this procedure until the exposed areas are within the limits described in Step 4.5.2.

4.6 2-ON-1 TRANSVERSE FILM ADJUSTMENT

4.6.1 With the SFD at minimum SID and the radiographic mode selected on the generator, insert an unexposed film cassette and advance it to the PARK position. The collimator shutters should be set to their maximum open position.

4.6.2 Select the 2-ON-1 transverse format and make two radiographic exposures. Develop the film and measure the exposed areas. The dimensions of each exposed area should be between 4.625" and 9.25" and 4.5" x 9.0" with no more than 3/16" gap or overlap between the images. If it is not, adjust "HALF" potentiometer, R15, on the SFD Interface Board to increase or decrease the exposed area as required.

NOTE: Adjusting R15 will also change the size of the images obtained on the 2-ON-1 longitudinal format setting. Compare the two films before making this adjustment.

4.6.3 Repeat this procedure if adjustment is required until the exposed areas are within the limits described in 4.6.2.

4.7 3-ON-1 FILM ADJUSTMENT

4.7.1 With the SFD at minimum SID and the radiographic mode selected on the generator, insert an unexposed film cassette and advance it to the PARK position. The collimator blades should be adjusted to their maximum open position.

4.7.2 Select the 3-ON-1 format and make three radiographic exposures. Develop the film and measure the exposed areas. The dimensions of each exposure should be between 9.25" x 3.125" and 9.00" x 2.875" with no more than 3/16" gap or overlap between the images. If it is not, adjust "1/3" potentiometer, R16, on the SFD Interface Board to increase or decrease the exposed area as required.

4.7.3 Repeat this procedure until the exposed areas are within the limits described in Step 4.7.2.

4.8 4-ON-1 FILM ADJUSTMENT

4.8.1 With the SFD at minimum SID and the radiographic mode selected at the generator, insert an unexposed film cassette and advance to the PARK position. The collimator blades should be set to their maximum open position.

4.8.2 Select the 4-0N-1 format and make four radiographic exposures. Develop the film and measure the exposed areas. The dimension of each exposed area should be between 4.625" x 4.625" and 4.5" x 4.5" with no more than 3/16" gap or overlap between the images.

If necessary, adjust "HALF" potentiometer, R15, a small amount to increase or decrease the size of the image.

NOTE: Adjusting R15 will have an effect on the image size obtained with the 2-ON-1 longitudinal and 2-ON-1 transverse formats. Compare the images obtained with those formats before making this adjustment.

4.8.3 If adjustment was necessary, repeat this procedure until the exposed areas are within the limits described in 4.8.2 .

4.9 6-ON-1 FILM ADJUSTMENT

4.9.1 With the SFD set at the minimum SID, select the radiographic mode on the generator. Load an unexposed cassette into the SFD and place the film in the PARK position. Open the shutter blades to their maximum open position.

4.9.2 Select the 6-ON-1 format and make six radiographic exposures on the film. Develop the film and measure the exposed areas. The dimensions of each exposure should be between 4.625" x 3.125" and 4.5" x 2.875" with no more than 3/16" gap or overlap between the images. If they are not, adjust "HALF" and "1/3" potentiometers, R15 and R16, to increase or decrease the image size.

NOTE: Adjustment of R15 and R16 will affect the image sizes previously obtained with the 2-ON-1 and 3-ON-1 format selections. Compare the images obtained with those formats before making this adjustment.

4.9.3 If adjustment was necessary, repeat this procedure until the exposed areas are within the limits described in 4.9.2.

4.10 9-ON-1 FILM ADJUSTMENT

4.10.1 With the SFD set at minimum SID, select the radiographic mode on the generator. Load an unexposed cassette into the SFD and place the film in the PARK position. Open the shutter blades to their maximum open position.

4.10.2 Select the 9-ON-1 format and make 9 radiographic exposures on the film. Develop the film and measure the exposed areas. The dimensions of each exposure should be between 2.75" x 2.75" and 2.5" x 2.5" with no more than 3/16" gap or overlap between the images. If they are not, adjust "1/9" potentiometer, R17, to increase or decrease the image size.

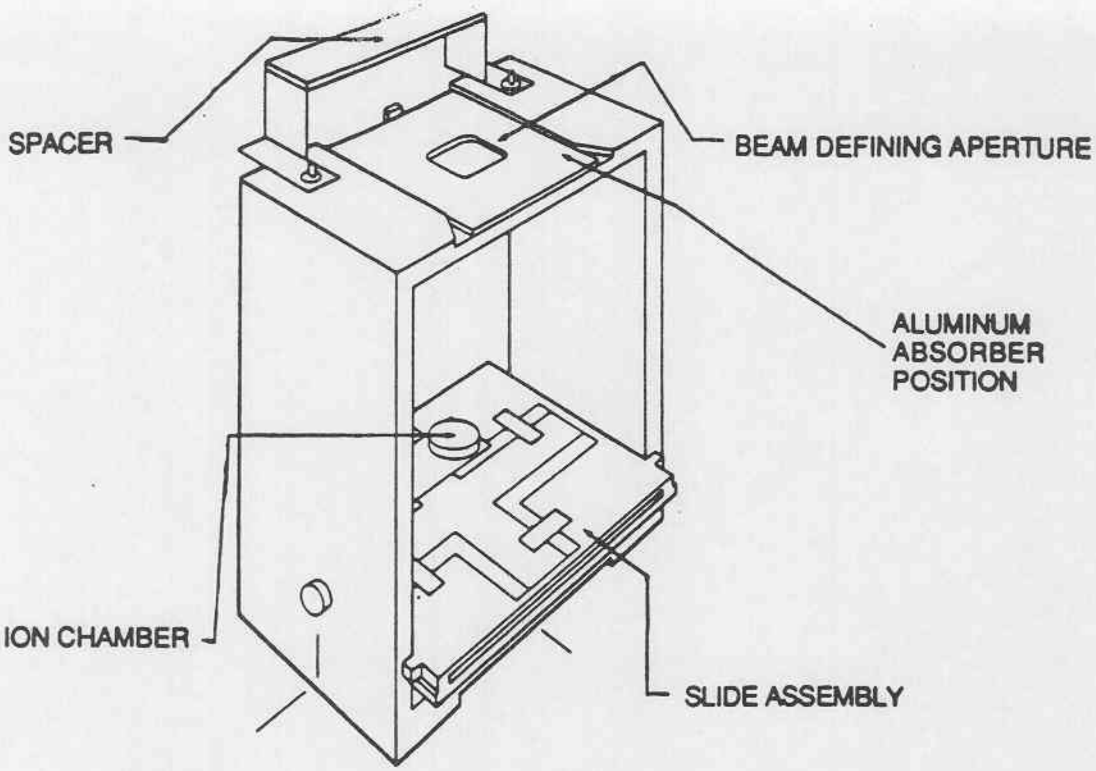
4.10.3 If adjustment was necessary, repeat this procedure until the exposed areas are within the limits described in 4.10.2.

4.11 SID TRACKING VERIFICATION

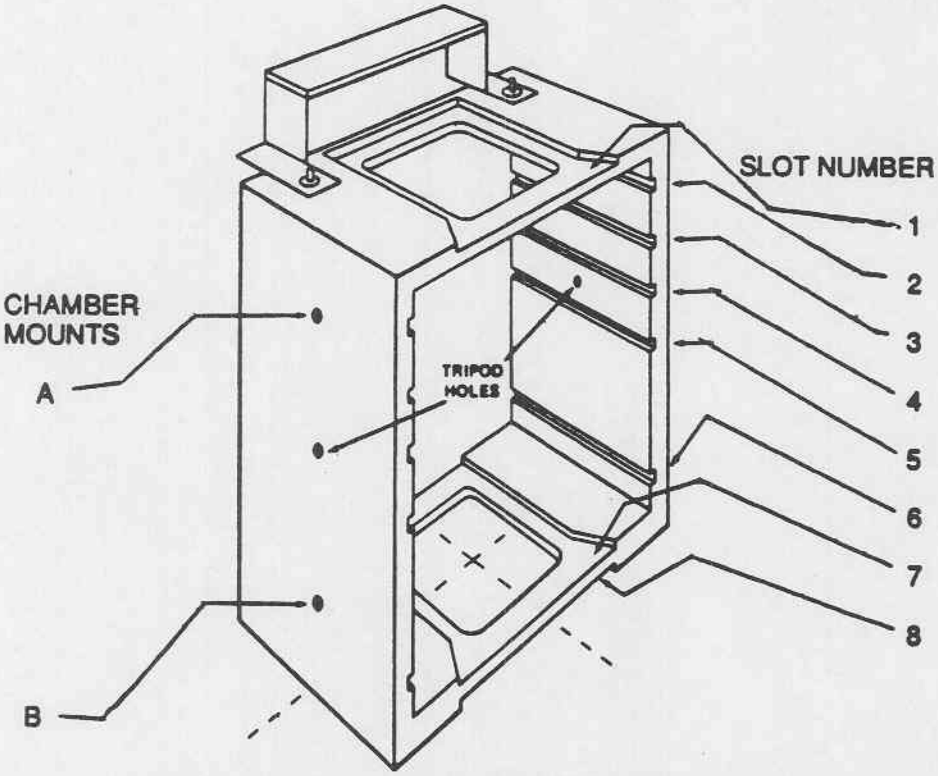
Raise the SFD to its maximum SID. Repeat Sections 4.4 through 4.10 and verify that the film sizes are within the limits specified for each format. If they are not, it may be necessary to re-calibrate the SID tracking system. Refer to Section 3.6 for adjustment.

SECTION 5.0

COMPLIANCE VERIFICATION


SPACER
BEAM DEFINING APERTURE
ALUMINUM ABSORBER POSITION
ION CHAMBER
SLIDE ASSEMBLY

CDRH/FDA COMPLIANCE TEST STAND
Figure 5.1


SLOT NUMBER
1
2
3
4
5
6
7
8
CHAMBER MOUNTS
A
TRIPOD HOLES
B

LEFT SIDE MOUNTING HOLES FOR COMPLIANCE TESTING

COMPLIANCE TEST STAND DETAIL
Figure 5.2

5.0 COMPLIANCE VERIFICATION

It is necessary for the assembler to verify compliance. A series of tests, when performed at the time of installation, will indicate compliance with 21CFR, Sub-Chapter J, Part 1020, Performance Standards.

The following tests are from the NEMA Standards Publication, No. XR 8-1979 (Test Methods for Diagnostic X-ray Machines for use during initial installation).

For each compliance item, there may be a variety of test methods described. Which method is used will depend on the tester's experience, availability of equipment, time, or special requirements of the Eureka Linear Collimator. Any reference to tolerances on compliance items are referenced directly from 21CFR, Sub-Chapter J, Regulations. They do not take into account inaccuracies brought about by the test equipment, instrumentation, or the human element. These factors must be considered when these tests are performed and the compliance of the equipment is being determined.

5.1 VERIFICATION TESTS TO BE PERFORMED:

	Test Procedure or Requirement	Applicable Paragraph
1.	Beam Quality	XR8/2.09
2.	Minimum Field Size	XR8/2.16
3.	X-ray Field Limitation and Alignment	XR8/2.20
4.	Fluoro X-ray Field Limitation	XR8/2.24
5.	Fluoro Source to Skin Distance (SSD)	XR8/2.25
6.	Primary Barrier - X-ray Lockout	XR8/2.27
7.	Alignment of X-ray Edges (Spotfilm)	XR8/2.29
8.	X-ray/IR Center Alignment (Spotfilm)	XR8/2.30

RECORD THE RESULTS ON THE *RECORD SHEET* SUPPLIED AT THE END OF THIS SECTION.

Radiation ☢ Warning for Diagnostic X-Ray Systems

X-rays are dangerous to both operator and others in the vicinity unless established safe exposure procedures are strictly observed.

The useful and scattered beams can produce serious, genetic or potentially fatal bodily injuries to any persons in the surrounding area if used by an unskilled operator. Adequate precautions must always be taken to avoid exposure to the useful beam, as well as to leakage radiation from within the source housing or to scattered radiation resulting from the passage of radiation through matter.

Those authorized to operate, test, participate in or supervise the operation of the equipment must be thoroughly familiar and comply completely with the currently established safe exposure factors and procedures described in publications such as Sub-Chapter J of Title 21 of the Code of Federal Regulations, "*Diagnostic X-ray Systems and their Major Components,*" and the National Council on Radiation Protection (NCRP) No. 33, "*Medical X-ray and Gamma-ray Protection for Energies up to 10 MeV-Equipment Design and Use,*" as revised or replaced in the future.

Failure to observe these warnings may cause serious, genetic or potentially fatal bodily injuries to the operator or those in the area.

XR 8-2.09 BEAM QUALITY (HALF-VALUE LAYER (HVL))

REQUIREMENT - The minimum beam quality requirements listed in Table 5-1 shall be met. (See 21 CFR 1020.30 (m).)

.01 METHOD I - VISUAL DETERMINATION OF HALF-VALUE LAYER (HVL)

A. GENERAL

The above HVL requirement will be considered to have been met if it can be demonstrated that the aluminum equivalent of the total filtration in the primary beam is not less than that shown in Table 5.2.

B. EQUIPMENT

None required.

TABLE 5-1 MINIMUM BEAM QUALITY REQUIREMENTS

KVp Range	Measured kVp	HVL (mmAl*)
Below 50	30	0.3
	40	0.4
	49	0.5
50 to 70	50	1.2
	60	1.3
	70	1.5
Above 70	71	2.1
	80	2.3
	90	2.5
	100	2.7
	110	3.0
	120	3.2
	130	3.5
	140	3.8
	150	4.1

*Type 1100 aluminum alloy as given in Aluminum Association Publication No. ASD-1, Aluminum Standards and Data.

TABLE 5-2 ALUMINUM EQUIVALENT OF PRIMARY BEAM TOTAL FILTRATION

Operating Voltage (kVp)	Total Filtration (mm Al Equivalent)
Below 50	0.5
50 - 70	1.5
Above 70	2.5

C. PROCEDURE

Visually inspect the system and determine the aluminum equivalence of the total filtration in the primary beam. This includes the inherent filtration of the X-ray tube, X-ray tube housing, beam-limiting device, and any additional filtration that may have been added in the useful beam (in fluoroscopic systems the tabletop is included as part of the added filtration).

D. VERIFICATION OF COMPLIANCE

The aluminum equivalence of the total filtration must be equal to or greater than the amount specified in Table 5-2.

NEMA Standard 5-15-1979

.02 METHOD II - STANDARD ABSORBER METHOD

A. GENERAL

This test is to be used when the surveyor cannot remove or see the total filtration equivalence.

The HVL determinations obtained from the following procedures are to be compared with those illustrated in Table 5-1. The HVL in millimeters of aluminum of the system being tested must be greater than or equal to the values shown in Table 5-1.

B. EQUIPMENT

1. Radiation detector.
2. Standard absorber with equivalent filtration of 2.5 millimeters of aluminum.

C. PROCEDURE

1. With the detection device positioned horizontally, an exposure is made at a preselected technique factor of 80 kVp and appropriate mA and time. The reading of the radiation output is recorded.
2. Position a total of 2.5 millimeters of aluminum at the port of the beam-limiting device and repeat the exposure using the same technique factors. Record the radiation output.

For X-ray units operating at low kVp (less than 50) and for mammography units, it will be necessary to use an aluminum absorber of 0.6 millimeters at 49 kVp.

D. VERIFICATION OF COMPLIANCE

Verify that the radiation output in Step 2 is greater than or equal to 50 percent of the radiation output in Step 1.

NEMA Standard 5-15-1979

.03 METHOD III - FDA/CDRH COMPLIANCE TEST

A. GENERAL

The HVL determinations obtained from the following procedures are to be compared with those illustrated in Table 5-1. The HVL in millimeters of aluminum of the system being tested must be greater than or equal to the values shown in Table 5-1.

B. EQUIPMENT

1. FDA/CDRH compliance test stand with accessories (Fig. 5.1).
2. Survey meter adapted for use with stand with an ion chamber.
3. Several sheets of aluminum, each having a thickness of 0.5 or 1.0 millimeter.

C. PROCEDURE

1. Attach the spacer, positioned out of the primary beam, to the test stand. Center the stand on the table. Center the source over the stand and bring the beam-limiting device down into firm contact with the spacer. Select the MANUAL mode of operation (there must not be a cassette in the cassette tray). Insert the beam-defining assembly in slot 1 of the stand with the leaded side up (see Fig. 5.2). Adjust the beam-limiting device so that the X-ray field slightly exceeds the aperture of the beam-defining assembly. Mount the ion chamber at position B with the chamber facing upward. Connect the chamber and meter with the cable provided. Select a tube potential that is commonly used and is in the highest kVp range of the X-ray system.

2. With no added filtration in the beam, make an exposure and record the reading. For all diagnostic X-ray equipment, use Table 5-3 to determine increments of filtration required to perform the half-value layer procedure. Make an exposure and record the reading for each total thickness.

TABLE 5-3 HIGHEST DESIGN OPERATING RANGE

Total Added Filtration, mm Al		
Below 50 kVp	**50-70 kVp**	**Above 70 kVp**
0.5	1.0	1.5
1.0	1.5	2.5
1.5	2.5	3.5
2.0	3.5	4.5

The recorded data is plotted on semi-log graph paper (Examples A and B, Fig. 5.3) and the half-value layer is read directly from the graph.

D. VERIFICATION OF COMPLIANCE

Verify that the half-value layer of the useful beam for a given X-ray tube potential is not less than the values shown in Table 5-1.

NEMA Standard 5-15-1979

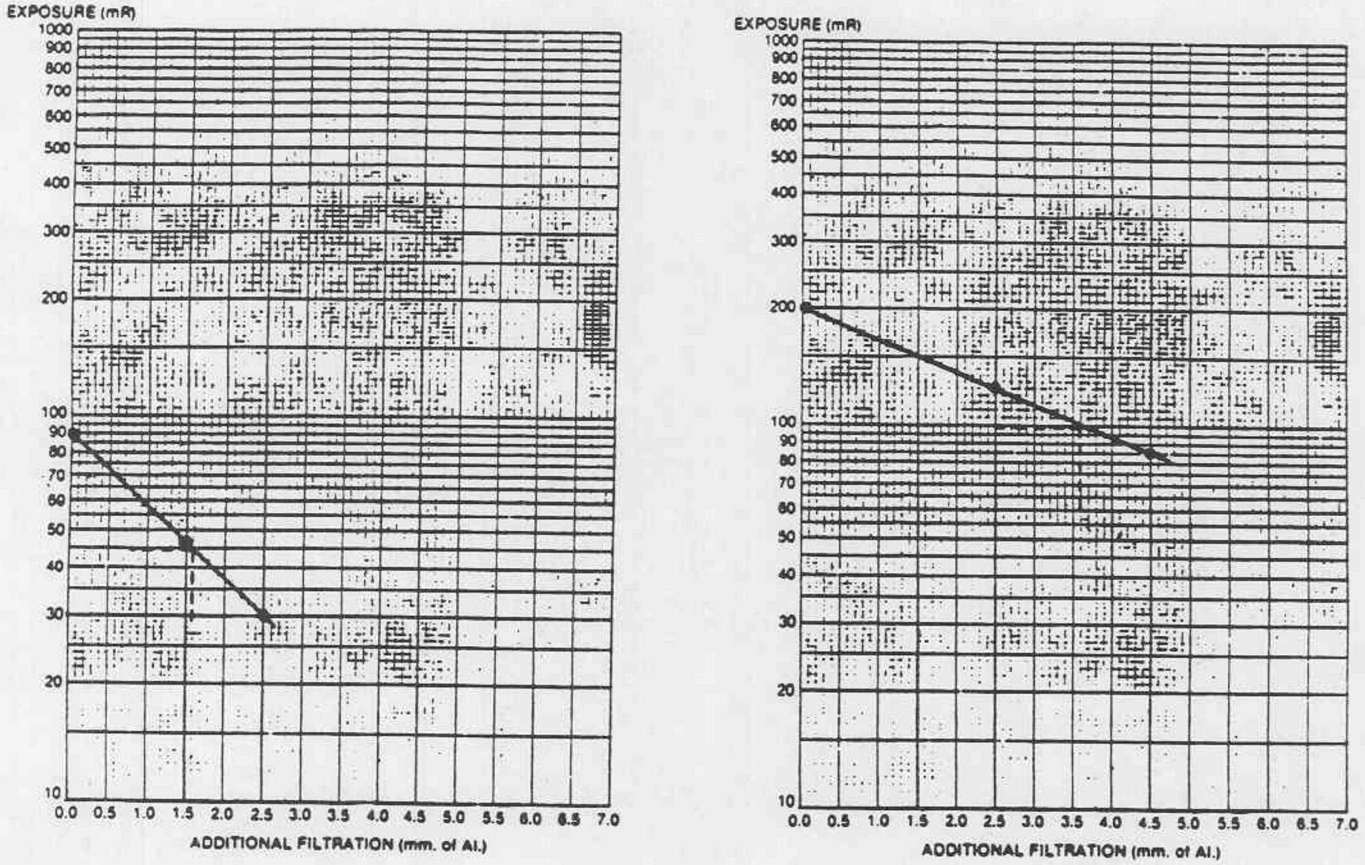
TABLE 5-4 HALF-VALUE LAYERS AS A FUNCTION OF FILTRATION AND TUBE POTENTIAL FOR DIAGNOSTIC UNITS*

Total Filtration mm Al	Peak Potential (kVp)									
	30	40	50	60	70	80	90	100	110	120
	Typical Half-Value Layers (mm Al)									
0.5	0.36†	0.47†	0.58	0.67	0.76	0.84	0.92	1.00	1.08	1.16
1.0	0.55	0.78	0.95	1.08	1.21	1.33	1.46	1.58	1.70	1.82
1.5	0.78	1.04	1.25†	1.42†	1.59†	1.75	1.90	2.08	2.25	2.42
2.0	0.92	1.22	1.49	1.70	1.90	2.10	2.28	2.48	2.70	2.90
2.5	1.02	1.38	1.69	1.95	2.16	2.37†‡	2.58†‡	2.82†‡	3.06†‡	3.30†‡
3.0	...	1.49	1.87	2.16	2.40	2.62	2.86	3.12	3.38	3.65
3.5	...	1.58	2.00	2.34	2.60	2.86	3.12	3.40	3.68	3.95

* For full-wave rectified potential.

† Recommended minimum HVL for radiographic units.

‡ Recommended minimum HVL for fluoroscopes.



EXAMPLE A

EXAMPLE B

BEAM QUALITY GRAPHING EXAMPLES
Figure 5.3

HALF-VALUE LAYER DETERMINATION GRAPHS

XR 8-2.16 MINIMUM FIELD SIZE

REQUIREMENT - Minimum field size at 100 centimeters (radiographic) or the maximum source-to-image distance (SID) (fluoroscopic) shall be less than or equal to 5 by 5 centimeters (See 21 CFR 1020.31 (d) (1), 1020.31 (e) (2), and 1020.32 (b) (2).)

.01 METHOD I - FILM METHOD

A. GENERAL

1. The following test is to be used for radiographic, fluoroscopic, and spotfilm devices.
2. This procedure need not be performed if it is apparent by visual means that the beam-limiting device can be adjusted to a size less than 5 by 5 centimeters at the specified SID.

B. EQUIPMENT

1. Cassette.
2. X-ray film or direct-print paper.

C. PROCEDURE 1 - RADIOGRAPHIC AND SPOTFILM DEVICES

1. Adjust the maximum SID obtainable (spotfilm devices or 100-centimeter radiographic devices).
2. Adjust the beam-limiting device to the smallest field size obtainable.
3. Load cassette and set proper technique factors.
4. Make an exposure.
5. Process film.

D. PROCEDURE 2 - FLUOROSCOPIC

1. Set fluoroscopic system for maximum SID and lock into position.
2. Remove all compression cones from the beam.
3. With the X-ray beam off, attach beam attenuator to the input surface of the image receptor.
4. Attach cassette to the bottom of the attenuator.
5. Close shutters as far as possible.
6. Set technique factors to assure proper exposure of the film.

7. Make exposure.

8. Process film.

E. VERIFICATION OF COMPLIANCE

Measure the X-ray field produced on film and verify that the field size is less than or equal to 5 by 5 centimeters.

NEMA Standard 5-15-1979

.02 METHOD II - VISUAL METHOD

A. GENERAL

1. The following tests are to be used for radiographic, fluoroscopic, and spotfilm devices.
2. These procedures need not be performed if it is apparent by visual means that the beam-limiting device can be adjusted to a size less than or equal to 5 by 5 centimeters at their specified source-to-image distance (SID).
3. These tests attempt to minimize radiation exposures as well as film processing by utilizing light-field visual display, or image display, or visual mechanical movement.

B. EQUIPMENT

Beam attenuator.

C. PROCEDURE I - RADIOGRAPHIC

1. Set the tube unit at a distance of 100 centimeters from the image receptor.
2. Pull out the bucky tray and place an unloaded cassette into the tray. *Do not reinsert bucky tray.*
3. Position source assembly over film cassette in the extended bucky tray.
4. Actuate the light-field and close shutters to minimum size. If the light is completely blocked from the image receptor, no further test is required.
5. Measure the light-field size on the cassette of the extended bucky tray.

D. VERIFICATION OF COMPLIANCE

Measured field size must be less than or equal to 5 by 5 centimeters.

E. PROCEDURE 2 - SPOTFILM/FLUOROSCOPIC

1. Set SID for maximum obtainable and lock in place.
2. Position beam attenuator to intercept entire X-ray beam.
3. Set appropriate technique factors (both spotfilm and fluoroscopic).
4. Close shutters to smallest size obtainable and make an exposure.

5. Verify on viewing device that there is no visual indication of radiation. If any radiation field is discernible, Method I must be utilized to determine minimum field size.

F. VERIFICATION OF COMPLIANCE

Verify that no visual indication of the radiation field is discernible.

NEMA Standard 5-15-1979

XR 8-2.20 X-RAY FIELD LIMITATION AND ALIGNMENT

REQUIREMENT - The X-ray field size in the plane of the image receptor, whether automatically or manually adjusted, shall be such that neither the length nor the width of the X-ray field differs from that of the image receptor by greater than 3 percent of the source-to-image distance (SID) and that the sum of the length and width differences without regard to sign be no greater than 4 percent of the SID, when the equipment indicates that the beam axis is perpendicular to the plane of the image receptor. (See 21 CFR 1020.31 (e) (2) (ii).)

.01 METHOD I - FDA/CDRH TEST STAND METHOD

A. EQUIPMENT

1. FDA/CDRH compliance test stand with accessories.
2. Slide assembly.
3. Plastic cassette containing a sheet of direct-print paper or X-ray film.
4. Ruler.
5. Cassette (preferably 8 by 10 inches or smaller).

B. PROCEDURE

1. Using the means provided, align the source assembly such that the beam axis is perpendicular to the image receptor.
2. Place the test stand on the table.
3. Position the spacer so as not to intersect the primary beam and secure with the pushbutton connectors.
4. Center the source assembly over the test stand using the means provided, e.g., the light-field used to define the X-ray field.
5. Bring the source assembly down into firm contact with the spacer.
6. Center the cassette tray with the source assembly using the means provided, e.g., bucky light.
7. Insert the plastic cassette into the slide assembly. Then insert the slide assembly into slot 5. (See Fig. 5.2.)

8. Center the film cassette in the cassette tray and insert into position. If the positive-beam limitation will not operate at this SID, raise the source assembly and lock in position at the first operable SID.

9. Make an exposure. Develop the image. Measure and record the length and width dimensions of the image.

10. Calculate the field size correction factor as the SID/A where:

    a. SID is the indicated source-to-image receptor distance, and;

    b. A is the indicated source-to-tabletop distance less 7.7 inches. Multiply each of the measured dimensions by the correction factor.

    X-ray field length at
    under-table image receptor = $\frac{SID}{A}$ x (X-ray field length at slot 5)

    X-ray field width at
    under-table image receptor = $\frac{SID}{A}$ x (X-ray field width at slot 5)

    Determine the difference without regard to sign between the corrected length and width dimensions and the corresponding cassette film size dimensions (8 by 10, 5 by 7, etc.). Each of these differences must be less than 3 percent of the SID, and the sum of these differences must be less than 4 percent of the SID.

    NEMA Standard 5-15-1979

.02 METHOD II - ALTERNATE TEST STAND METHOD

A. GENERAL

Prior to performing this test the magnification factor must be determined in accordance with the X-ray/Light-Field Alignment Test - Method III.

B. EQUIPMENT

1. Manufacturer's recommended test stand.

2. Cassette with film.

C. PROCEDURE

1. Align the tube unit and image receptor and set SID to the value determined in the actual versus indicated SID test.

2. Insert empty 8 by 10 inch cassette into bucky tray.

3. Position test stand in accordance with manufacturer's instructions.

4. Load a second cassette and place in the designated position.

5. Select the proper technique factors, make an exposure, and develop film.

6. Measure the length and width of the X-ray image on the film.

7. Multiply each measurement by the magnification factor previously determined.

D. VERIFICATION OF COMPLIANCE

Verify that the X-ray field size in the plane of the image receptor does not differ from that of the image receptor by greater than 3 percent of the SID and that the sum of the length and width differences without regard to sign is not greater than 4 percent of the SID.

NEMA Standard 5-15-1979

.03 METHOD III - CASSETTE METHOD

A. GENERAL

This procedure can be used only when a capability is provided for overriding positive-beam limitation.

B. EQUIPMENT

1. Large cassette with film.

2. Small cassette, empty.

C. PROCEDURE

1. Insert empty smaller cassette into bucky tray.

2. Switch system to the override mode.

3. Remove the smaller cassette and insert the loaded large cassette.

4. Select the proper technique factors, make an exposure, and develop film.

5. Measure the length and width of the X-ray image on the film.

D. VERIFICATION OF COMPLIANCE

Verify that the X-ray field size in the plane of the image receptor does not differ from that of the image receptor (smaller cassette) by greater than 3 percent of the SID and that the sum of the length and width differences without regard to sign is not greater than 4 percent of the SID.

NEMA Standard 5-15-1979

XR 8-2.24 FLUOROSCOPIC X-RAY FIELD LIMITATION

REQUIREMENT

A. NONIMAGE-INTENSIFIED FLUOROSCOPY

The X-ray field by nonimage-intensified fluoroscopic equipment shall not extend beyond the entire visible area of the image receptor. This requirement applies to field size during fluoroscopic procedures.

B. IMAGE-INTENSIFIED FLUOROSCOPY

1. During fluoroscopic procedures, neither the length nor the width of the X-ray field in the plane of the image receptor shall exceed the visible area of the image receptor by more than 3 percent of the source-to-image distance (SID). The sum of the excess length and the excess width shall be no greater than 4 percent of the SID.

2. Compliance shall be determined with the beam axis perpendicular to the image receptor. For rectangular X-ray fields used with circular image receptors, the error in alignment shall be determined along the length and width dimensions of the X-ray field which pass through the center of the visible area of the image receptor. (See 21 CFR 1020.32 (b).)

.01 METHOD I - FDA/CDRH TEST STAND METHOD

A. EQUIPMENT

1. FDA/CDRH compliance test stand and accessories.
2. Brass or copper attenuation block.
3. Plastic cassette and direct-print paper or redipack film cassette.

B. PROCEDURE

1. Position all movable grids and compression cones out of the path of the primary beam. If necessary, level the table and retract the spotfilm carriage. If the system utilizes a television monitor, turn it on and allow time for warmup.
2. Place the test stand in the approximate center of the table.
3. Insert the slide assembly, grid side down, into slot 5 (See Fig. 5.2.)
4. Place attenuator block on top of slide assembly.
5. Fully open the beam-limiting device.
6. Center the image receptor over the test stand by observing the image of the grid on the image receptor.
7. Bring the imaging assembly down into firm contact with the top of the stand.

8. If using a dual-field image intensifier, e.g., 6- and 9-inch capability, select the mode of largest image magnification, e.g., 6-inch mode in this case.

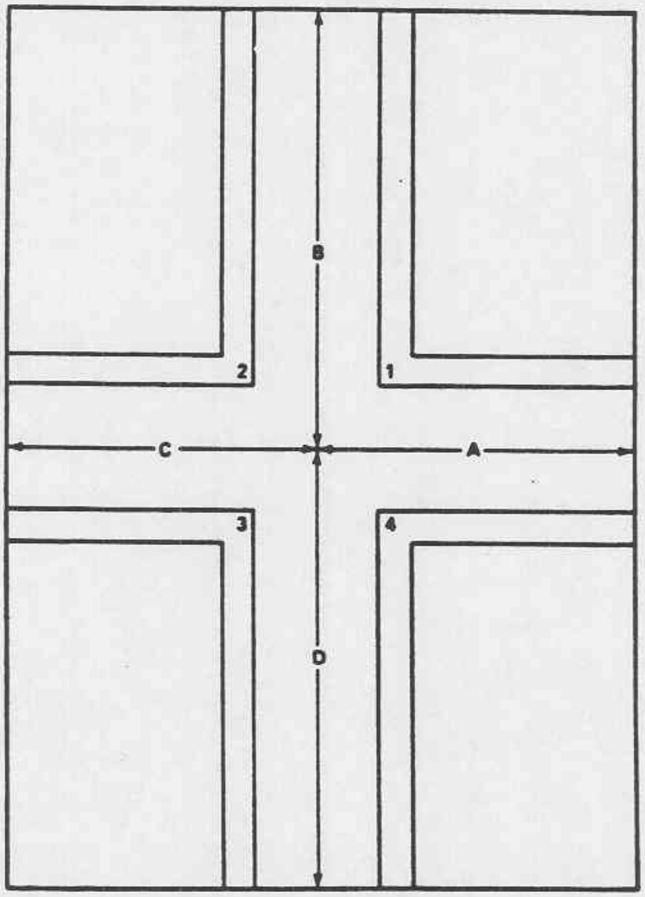
9. Adjust the controls to obtain the best quality image.

10. Insert a plastic cassette containing a sheet of direct-print paper or redipack film cassette into the slide assembly and make an exposure.

11. At the image output, count the units from the center of the grid to each edge of the image as shown by lines A, B, C, and D of Fig. 5.4.
Note that line A passes between grid numbers 1 and 4, B passes between numbers 1 and 2, etc. Record the measurements in order.

12. Develop the film and outline the perimeter of the image.

13. Count the units from the center of the grid to each edge as you did with A, B, C, and D, above. Record these as A'. B'. C', and D'.



FLUOROSCOPIC X-RAY FIELD LIMITATION, TEST STAND METHOD
Figure 5.4

C. VERIFICATION OF COMPLIANCE

For compliance of nonimage-intensified systems, A shall be less than or equal to A', B shall be less than or equal to B', C shall be less than or equal to C', and D shall be less than or equal to D'.

For image-intensified systems, determine the source-to-slot-5 distance by adding 18.5 centimeters (7.3 in) to the minimum source-to-skin distance (SSD) determined by the SSD test procedure using the FDA/CDRH test stand. Calculate and record 3 percent and 4 percent of this distance. Determine the difference, without regard to sign, of A and A', B and B', C and C', and D and D'. Sum the differences. They must be less than or equal to 4 percent of the source-to-slot-5 distance. In addition, the sum of the A and A' plus the C and C' differences and the sum of the B and B' plus D and D' differences must each be less than or equal to 3 percent of the source-to-slot-5 distance.

.02 METHOD II - DIRECT METHOD

A. EQUIPMENT

1. Lead foil phantom or copper attenuator.
2. Direct-print paper.
3. One- by 1-inch steel marker.
4. Four additional metal markers (each marker is approximately 1/32-inch galvanized sheet metal having the dimensions of 1.5 by 0.5 inches).

B. PROCEDURE - NONIMAGE-INTENSIFIED FLUOROSCOPE

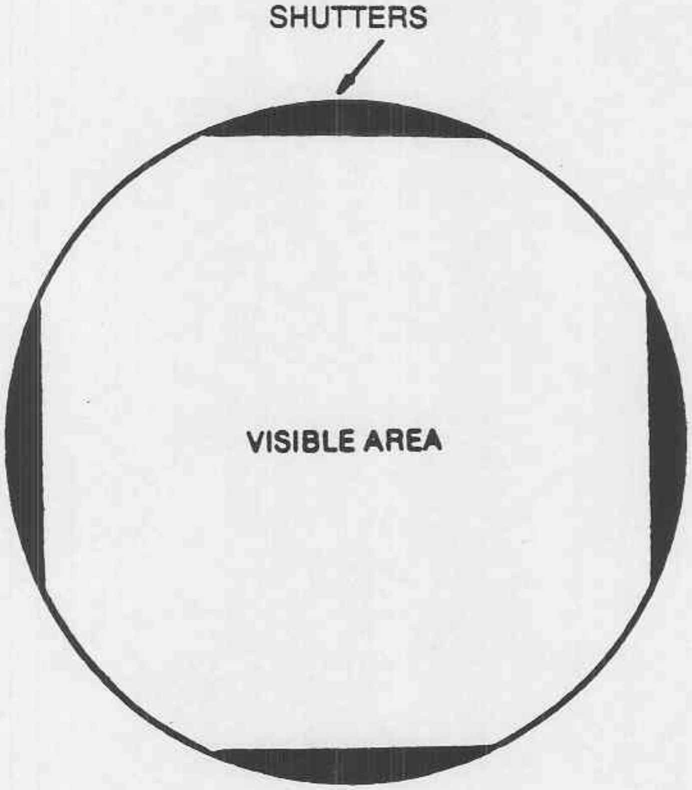
1. Place the image receptor as close as possible to the tabletop.
2. Open the shutters to the maximum and activate the fluoroscopic tube.
3. Slowly increase the distance between the tabletop and the image receptor. The unit is in compliance if, at the greatest extension of the image receptor, there is an unilluminated border all around the visible area of the image receptor. No further tests need be made.
4. If the illuminated area expands to the edges of the visible area of the image receptor, lower the image receptor until there is a small unilluminated border.
5. Close the shutters to produce approximately a 2-inch wide unilluminated border. Resume increasing image-receptor-to-tabletop distance. The unit is not in compliance if the illuminated area continues to expand.
6. If the illuminated area does not expand, then at the maximum SID, slowly open the shutters to the maximum. The unit is in compliance if the illuminated area does not expand.

C. PROCEDURE - IMAGE-INTENSIFIED FLUOROSCOPE (Overtable Tube, Variable Collimator)

This procedure can be used only if the distance from the input phosphor to the tabletop does not change with SID and if the SID is variable.

1. Raise the tube housing to its greatest SID and, if the beam-limiting device is not automatic, close the shutters to their fullest extent.

2. Activate the tube and slowly increase the field size while observing the monitor. If at the maximum field size it is obvious that the image of the beam-limiting device is apparent at the edge of the image receptor, no further test need be made. (See Fig. 5.5.)



FLUOROSCOPIC X-RAY FIELD LIMITATION, DIRECT METHOD
Figure 5.5

3. If there is no unilluminated area at any of the edges of the image receptor, lower the tube head until the bottom of the beam-limiting device is at its minimal distance from the tabletop (or 12 inches, whichever is greater). Record this distance.

4. Place a lead foil phantom or copper attenuator on the tabletop and center a loaded cassette in the light-field (Fig. 5.6)

5. Adjust the light-field to give a 5- by 7-inch field on the cassette and mark the edges with metal markers.

6. Attach a 1- by 1-inch steel marker to the center of the bottom of the beam-limiting device. (Exact centering is not necessary.)

7. Make an appropriate exposure.

8. Develop the direct-print paper or film and check light and X-ray beam alignment.

9. Measure length of marker image.

10. By similar triangles, determine the source-to-tabletop distance.

11. This procedure can continue only if the unit is aligned to radiographic requirements (plus or minus 2 percent SID). Raise the tube head to maximum SID.

12. Mark the edges of the visible area by placing two radiopaque markers within the light-field and parallel to each other and to the edges of the light-field.

13. While viewing the markers through the image intensifier, activate the tube on and off, adjusting the parallel markers between exposures until the outer edges of the markers are no longer visible (Fig. 5.7)

14. Again, turn on the light-field and measure the distance from the edges of the light-field to the parallel markers.

15. To determine the maximum source-to-tabletop distance, subtract the beam-limiting-device-to-tabletop distance previously determined from the source-to-tabletop distance as previously calculated and add this result to the measured distance from the bottom of the beam-limiting device to the tabletop. Calculate the percent of the SID of the X-ray field that is in excess of the visible area.

16. Place the markers at right angles to the original position and repeat the last three steps.

NEMA Standard 5-15-1979

D. PROCEDURE - IMAGE-INTENSIFIED FLUOROSCOPE (Undertable Tube, Variable Collimator)

1. Attach a beam attenuator to the bottom of the image receptor housing. Raise the image receptor housing to its greatest SID and close the shutters to the fullest extent. Activate the tube and slowly increase the field size while observing the monitor. If at the maximum field size it is obvious that the image of the beam-limiting device is apparent at the edge of the image receptor, no further test need to be made. (See Fig. 5.8.)

2. Place markers on tabletop, continue to activate the tube intermittently, and between exposures move the markers to the edges of the visible area of the image receptor (Fig. 5.8).

3. Place a 1- by 1-inch steel marker on the tabletop approximately centered between the markers.

4. Center a cassette loaded with direct-print paper or redipack over the markers. Attach a second cassette to the bottom of the beam attenuator, adjust the image receptor to 30 centimeters (12 in) above the tabletop or the minimum beam attenuator-to-tabletop distance, whichever is greater, and center it over the bottom cassette (Fig. 5.9). Measure the distance.

5. Activate the tube for an appropriate exposure of direct-print paper or the redipack film.

6. Develop the direct-print papers or the films. Measure the length of the marker image on the upper sheet. Calculate the distance from the tabletop to the source by the similar triangle method. Use this distance as the SID in the next step (7).

7. On the lower sheet measure the distance from the edges of the exposed area to the outer edge of the marker. Calculate the percent of the SID of the X-ray field in excess of the visible area.

8. Place the radiopaque markers at right angles to the original position and repeat the procedure.

E. VERIFICATION OF COMPLIANCE

For nonimage-intensified fluoroscopy, verify that the X-ray field does not extend beyond the visible area of the image receptor.

For image-intensified fluoroscopy, verify that neither the length or width misalignment exceeds the visible area of the image receptor by more than 3 percent of the SID. The sum of the excess length and the excess width shall be no greater than 4 percent of the SID.

NEMA Standard 5-15-1979

OVERTABLE TUBE

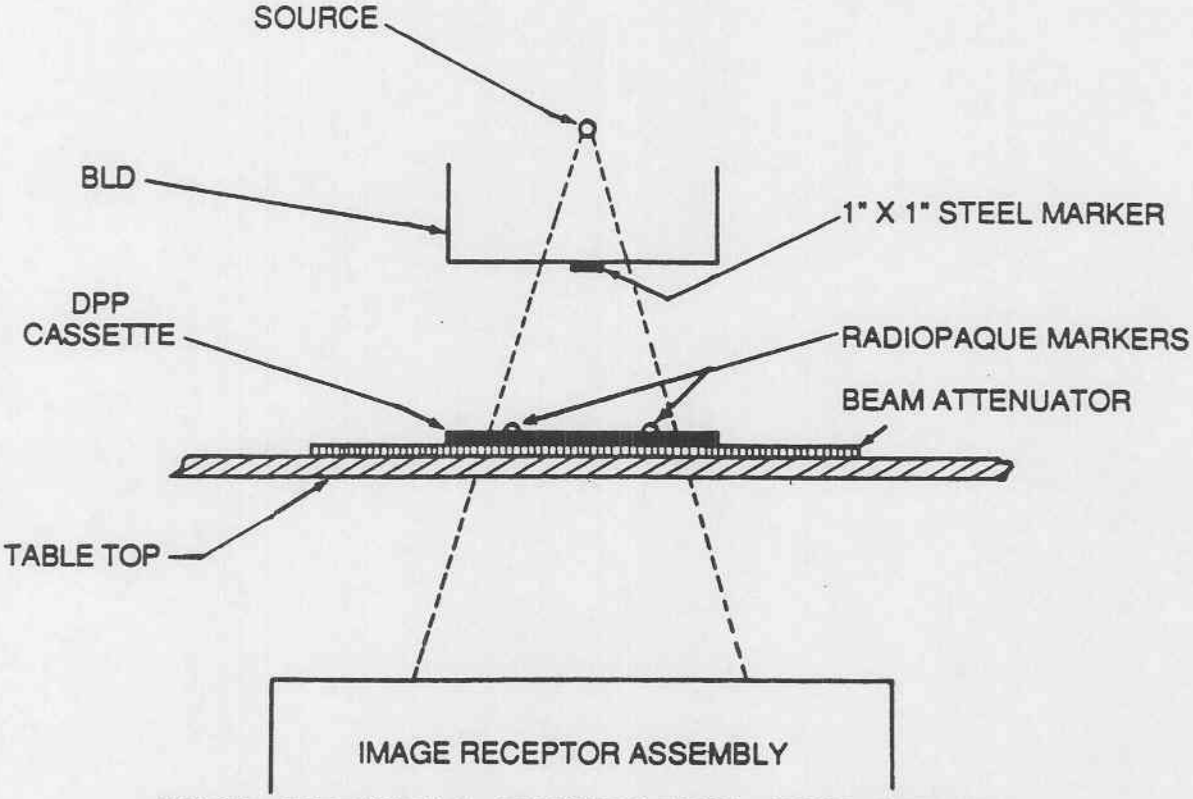

SOURCE
BLD
1" X 1" STEEL MARKER
DPP CASSETTE
RADIOPAQUE MARKERS
BEAM ATTENUATOR
TABLE TOP
IMAGE RECEPTOR ASSEMBLY

IMAGE INTENSIFIED FLUOROSCOPE, TEST SET-UP
Figure 5.6

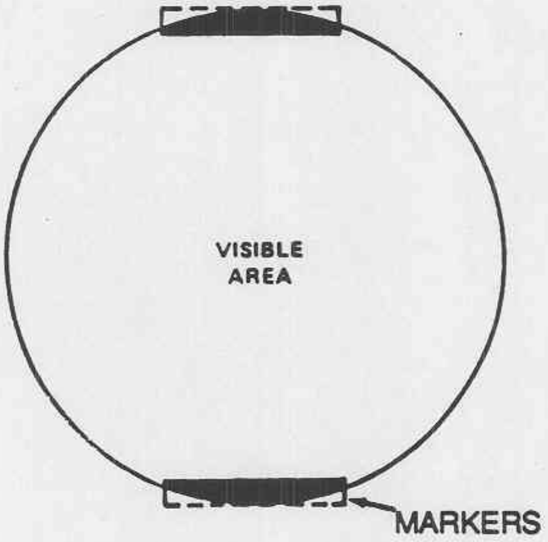

VISIBLE AREA
MARKERS

IMAGE INTENSIFIED FLUOROSCOPE, METAL MARKER METHOD, INSIDE EDGE
Figure 5.7

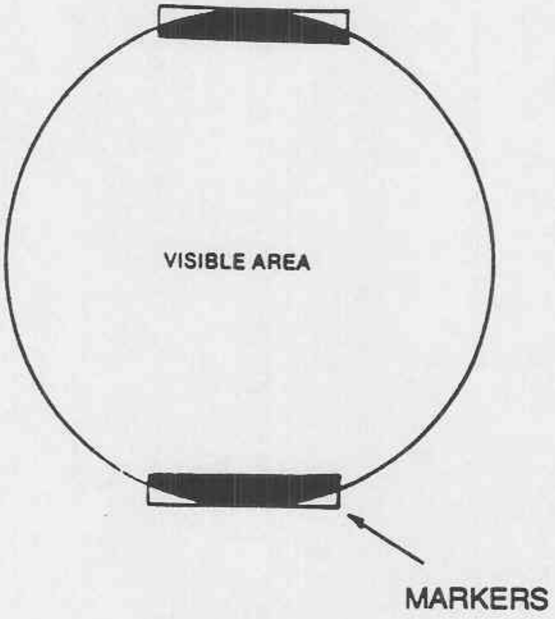
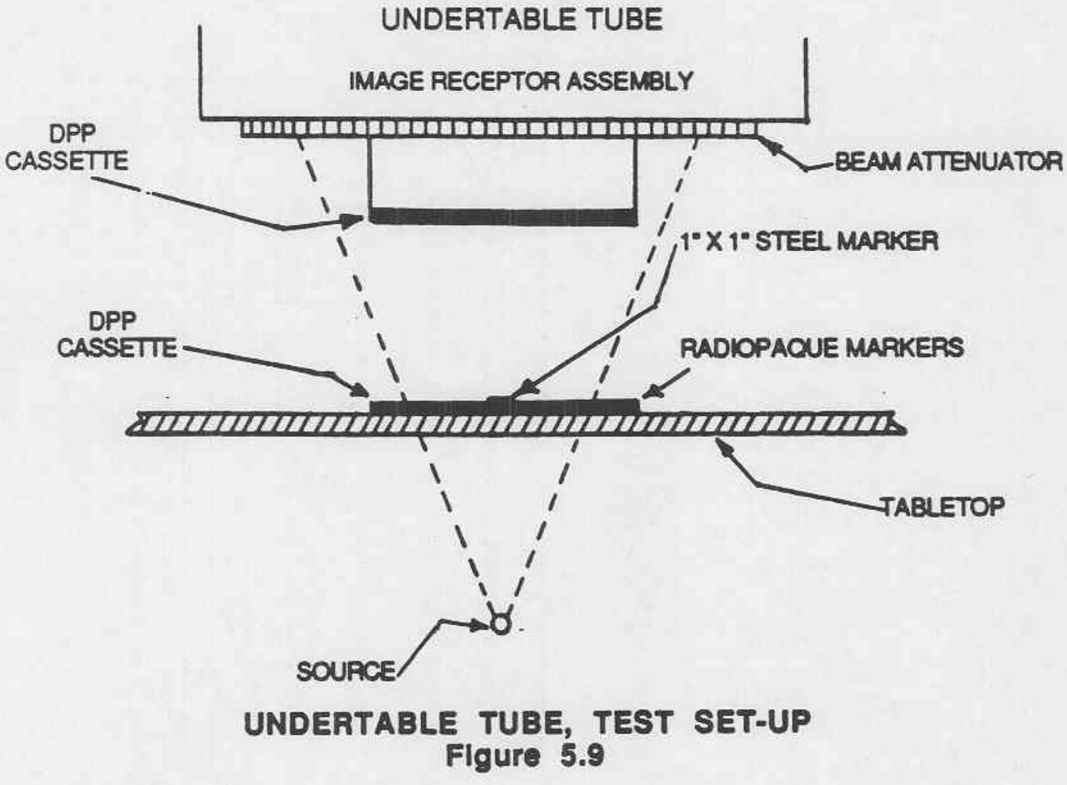

VISIBLE AREA
MARKERS

IMAGE INTENSIFIED FLUOROSCOPE, METAL MARKER METHOD, OUTSIDE EDGE
Figure 5.8


UNDERTABLE TUBE
IMAGE RECEPTOR ASSEMBLY
DPP CASSETTE
BEAM ATTENUATOR
1" X 1" STEEL MARKER
DPP CASSETTE
RADIOPAQUE MARKERS
TABLETOP
SOURCE

UNDERTABLE TUBE, TEST SET-UP
Figure 5.9

XR 8-2.25 FLUOROSCOPIC SOURCE-TO-SKIN DISTANCE (SSD)

REQUIREMENT - The source-to-skin distance (SSD) shall be not less than 38 centimeters (15 in) on stationary fluoroscopes. (See 21 CFR 1020.32 (f).)

A. GENERAL

If the SSD can be measured directly, no further testing is necessary.

B. EQUIPMENT

1. FDA/CDRH compliance test stand with accessories (Fig. 5.1).
2. Plastic cassette and direct-print paper or redipack film cassette.
3. Brass or copper attenuation block.

C. PROCEDURE

1. Position all movable grids and compression cones out of the primary beam. If necessary, return the table to the horizontal position and raise the spotfilm carriage. If the system utilizes a television monitor, turn it on and allow time for warmup.
2. Place the test stand in the approximate center of the table.
3. Insert the slide assembly, grid side down, at slot 3 (See Fig. 5.2.).
4. Place attenuation block on the top of slide assembly.
5. Fully open the beam-limiting device.
6. Center the image receptor over the test stand by observing the image of the grid on the image receptor.
7. Bring the image assembly down into firm contact with the spacer bar on the top of the stand.
8. Slide the focal spot assembly, brass side up, into slot 7.
9. Insert the plastic cassette or the redipack film cassette into the slide assembly.
10. Make an exposure assuring proper density on the film or paper.
11. Remove the cassette and develop the direct-print paper or film.
12. Measure the minimum separation of the outside edges of the focal spot strips (See Fig. 5.10).

D. CALCULATIONS

Calculate the minimum SSD.

Minimum SSD (in inches) =

$$\frac{28.25\ \text{in}^2}{(\text{image size in inches} - 2.5)} - 0.4\ \text{in}$$

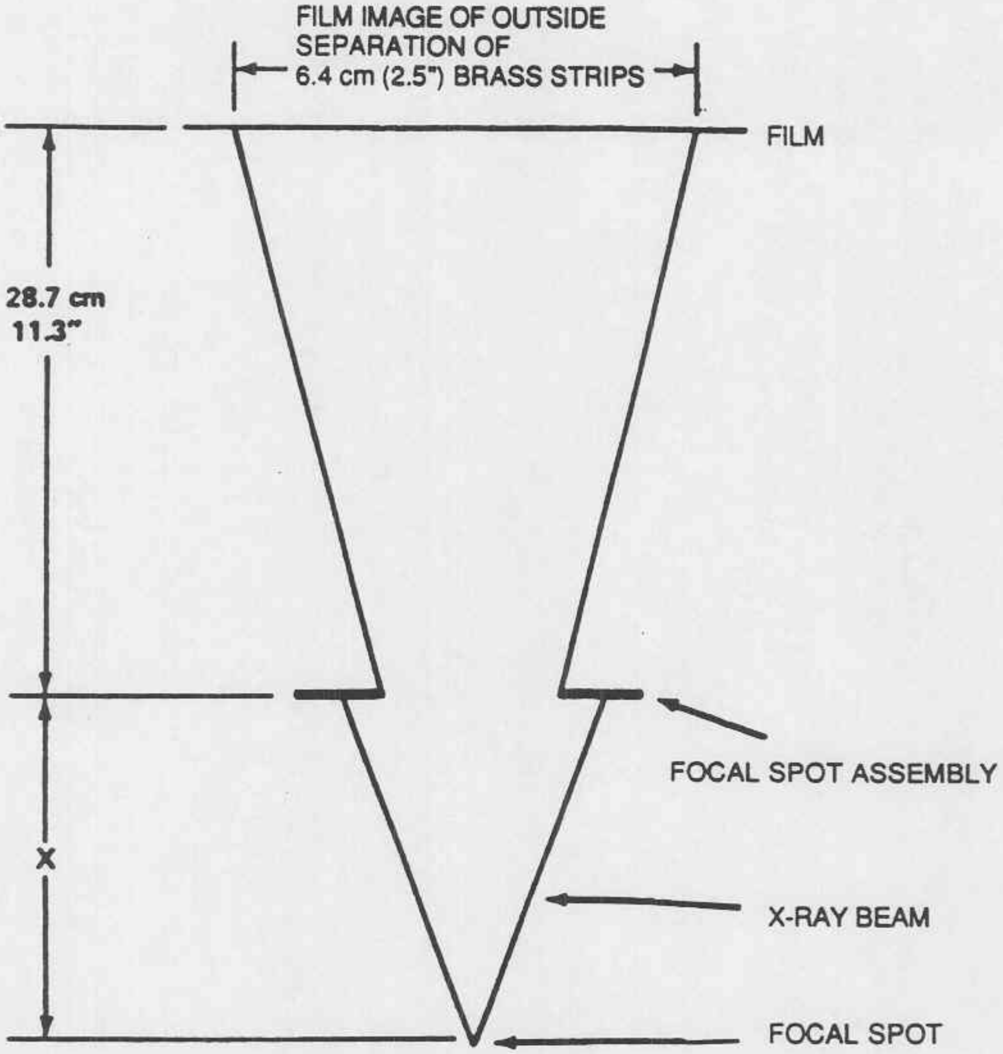
Minimum SSD (in centimeters) =

$$\frac{182.3\ \text{cm}^2}{(\text{image size in cm} - 6.4)} - 1.0\ \text{cm}$$

E. VERIFICATION OF COMPLIANCE

Verify that the SSD is not less than 38 centimeters (15 in).

NEMA Standard 5-15-1979


FILM IMAGE OF OUTSIDE
SEPARATION OF
6.4 cm (2.5") BRASS STRIPS
FILM
28.7 cm
11.3"
FOCAL SPOT ASSEMBLY
X
X-RAY BEAM
FOCAL SPOT

EQUATION: $X = \frac{182.3\ \text{cm}^2}{(\text{IMAGE SIZE IN CENTIMETERS} - 6.4\ \text{CM})}$

EQUATION: $X = \frac{28.25}{(\text{IMAGE SIZE IN INCHES} - 2.5)}$

MINIMUM SSD (IN CENTIMETERS) = X - 1.0 cm

MINIMUM SSD (IN INCHES) = X - 0.4"

FOCAL SPOT GEOMETRY
Figure 5.10

XR 8-2.27 PRIMARY BARRIER - X-RAY LOCKOUT

REQUIREMENT - For equipment manufactured after February 25, 1978, when the angle between the image receptor and the beam axis is variable, means shall be provided to indicate when the axis of the X-ray beam is perpendicular to the plane of the image receptor.

The fluoroscopic tube shall not produce X-rays unless the barrier is in position to intercept the entire useful beam. (See 21 CFR 1020, 32 (a) and 1020.32 (b) (2) (iii).)

A. VERIFICATION OF COMPLIANCE

Move the primary barrier off the detents position and verify that X-rays cannot be produced by the fluoroscopic X-ray tube. Verify that, if the beam angulation is variable, a means is provided to indicate that the beam axis is perpendicular to the plane of the image receptor.

NEMA Standards 5-15-1979

SPOTFILM RADIOGRAPHIC TESTS

XR 8-2.29 ALIGNMENT OF X-RAY FIELD EDGES TO SELECTED PORTIONS OF THE IMAGE RECEPTOR

REQUIREMENT - The misalignment of the X-ray field with that portion of the image receptor selected on the spotfilm device, along either the length or the width dimension, shall not exceed 3 percent of the source-to-image-receptor distance (SID), and the total misalignment without regard to sign along both dimensions shall not exceed 4 percent of the SID. (See 21 CFR 1020.31 (g).)

A. GENERAL

Technique factors must be selected for a film density of approximately 1.0.

B. EQUIPMENT

1. Manufacturer's recommended test stand.
2. Graduated template.
3. Two cassettes.
4. Film.

C. PROCEDURE

1. Verify by the means provided that the axis of the X-ray beam is perpendicular to the plane of the image receptor (applicable only where variable beam angulation is provided).
2. Load the cassette with film and place in the spotfilm device.
3. Position test stand in accordance with manufacturer's instructions.
4. Load a second cassette with film and place in the designated position on the test stand. *This film must be large enough to accept a one-on-one format.*
5. Place graduated template in a position between the X-ray source and the two cassettes.
6. Select proper technique factors and a one-on-one spotfilm format.
7. Make an exposure and develop films.
8. Repeat steps 1 through 7 for each available spotfilm format.

D. CALCULATIONS

1. Calculate the magnification factor by measuring the distance between the same two points on the graduated template image on each of the two films. The two points chosen must be as far apart as possible. Divide the smaller measurement into the larger measurement to determine the magnification factor.
2. If the source-to-test stand film distance is known, calculate the actual SID by multiplying the magnification factor by the known source-to-test film distance.
3. If the source-to-test stand film distance is not known, measure the actual distance from the graduated template position to the test stand film plane (distance Z, see Fig. 5.11).
4. Calculate the source-to-template distance (distance X) using the following formula:

$$\frac{A}{B} = \frac{X}{X + Z} \text{ or } X = \frac{A\ Z}{B - A}$$

where:

A = two points on a graduated template.

B = magnification of the same two points on
the graduated template as used in A.

5. Calculate the source-to-test stand film distance by adding distance X and distance Z. Multiply the source-to-test stand film distance by the magnification factor determined in step 1 to determine the actual SID.

6. On the test stand film measure and record distances a, b, c, and d from the center of the graduated template to each respective edge of the radiographic image (see Fig. 5.12).

7. Multiply each distance a through d by the magnification factor and record the products as a', b', c', and d'. Note that a', b', c', and d' are the respective distances they would have been if they had been recorded at the spotfilm plane.

8. On the spotfilm image measure distances A, B, C, and D from the center of the graduated template image to each respective edge of the selected portion of the spotfilm (see Fig. 5.13). Record distances A, B, C, and D as measured.

9. Calculate the length differences and width differences without regard to sign as follows:

$$\text{Length difference} = |B - b'| + |D - d'|$$

$$\text{Width Difference} = |A - a'| + |C - c'|$$

Record the sum of the length and width differences.

E. VERIFICATION OF COMPLIANCE

1. Calculate 3 and 4 percent of the actual SID and record.

The individual length and width misalignment, regardless of sign, must be less than or equal to 3 percent of the SID as calculated in step 1. The summation of the length and width misalignments, regardless of sign, must be less than or equal to 4 percent of the SID as calculated in step 1.

NEMA Standard 5-15-1979

XR 8-2.30 ALIGNMENT OF CENTER OF X-RAY FIELD TO CENTER OF SELECTED PORTION OF IMAGE RECEPTOR

REQUIREMENT - The center of the X-ray field in the plane of the film shall be aligned with the center of the selected portion of the film to within 2 percent of the source-to-image distance (SID). (See 21 CFR 1020.31 (g) (4).)

A. GENERAL

1. All exposures taken during this test should have a uniform film density of approximately 1.0.

2. The actual SID must be determined prior to performing this test.

B. EQUIPMENT

Radiographic cassette and film.

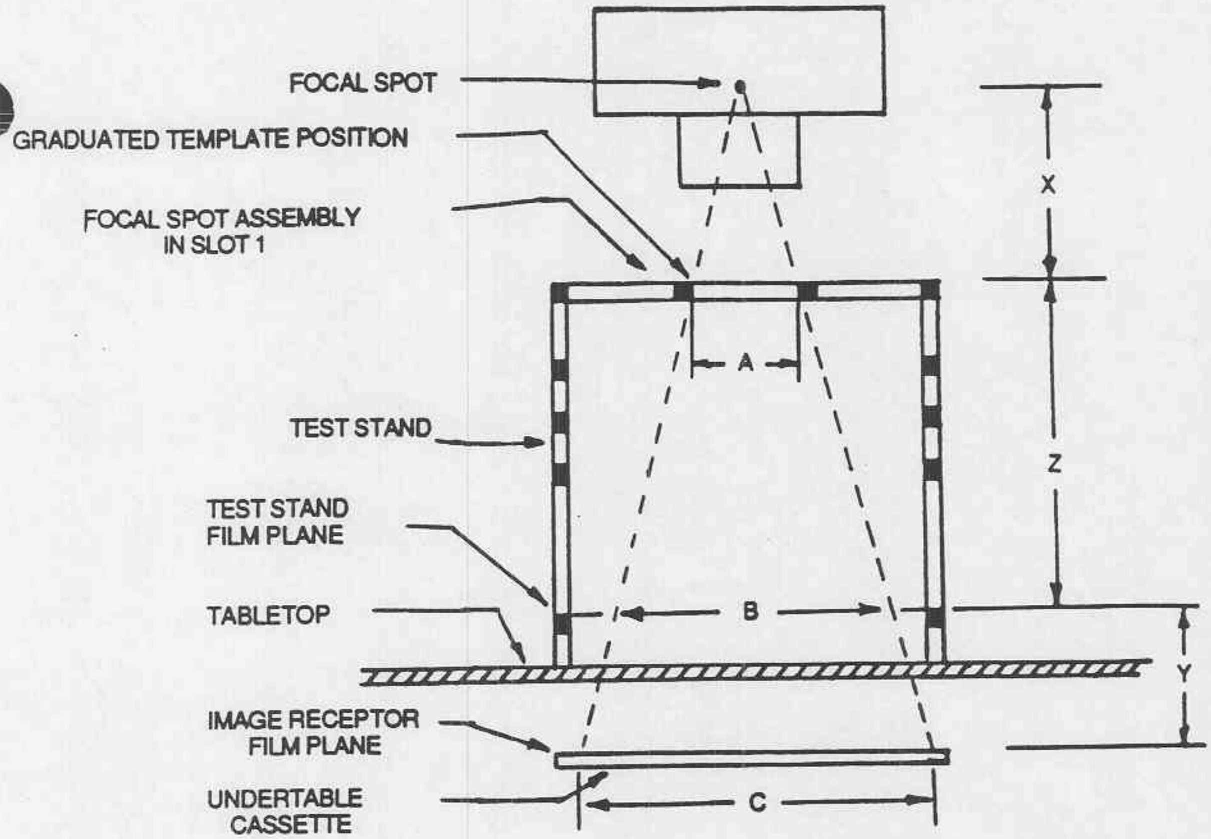
C. PROCEDURE

1. Load cassette with film and place in the spotfilm device.
2. Select a one-on-one spotfilm format.
3. Assure that the SID is set to the value previously determined in the actual SID determination test.
4. Reduce the X-ray field size to a size slightly smaller than the size of the film area to be exposed.
5. Make an exposure and develop film.
6. Repeat steps 1 through 5 for each available spotfilm format.
7. To determine the centers of the X-ray films draw diagonals across the film (the point where these two lines cross is the center of the film).
8. To determine the corners of the image recorded on the film, locate two points on each side of the four sides of the image. Through the two points on each side draw a straight line. These four lines when extended intersect making a rectangle which is a close approximation of the actual X-ray field. Draw diagonals across the rectangular figure determined. The point at which the two diagonals cross is assumed to be the center of the X-ray field.
9. The distance from the film center mark is measured and recorded as the linear displacement or misalignment of the centers of the image receptor and the X-ray field.

D. VERIFICATION OF COMPLIANCE

Verify that this distance is less than or equal to 2 percent of the SID.

NEMA Standard 5-15-1979


FOCAL SPOT
GRADUATED TEMPLATE POSITION
FOCAL SPOT ASSEMBLY IN SLOT 1
TEST STAND
TEST STAND FILM PLANE
TABLETOP
IMAGE RECEPTOR FILM PLANE
UNDERTABLE CASSETTE
A
B
C
X
Z
Y

EXAMPLE:

Let A = 2 $\qquad \frac{A}{B} = \frac{X}{X + Z} \qquad \frac{B}{C} = \frac{X + Z}{X + Z + Y}$

$B = 3\frac{3}{8} = \frac{27}{8} = \frac{54}{16} \qquad \frac{2}{\frac{27}{8}} = \frac{X}{X + \frac{231}{16}} \qquad \frac{\frac{54}{16}}{\frac{61}{16}} = \frac{\frac{567}{16}}{\frac{567}{16} + Y}$

$C = 3\frac{13}{16} = \frac{61}{16}$

$Z = 14\frac{7}{16} = \frac{231}{16} \qquad 2X + \frac{231}{8} = \frac{27X}{8} \qquad \frac{54}{16} \cdot \frac{567}{16} + \frac{54Y}{16} = \frac{567}{16} \cdot \frac{61}{16}$

$X + Z = 21 + 14\frac{7}{16}$

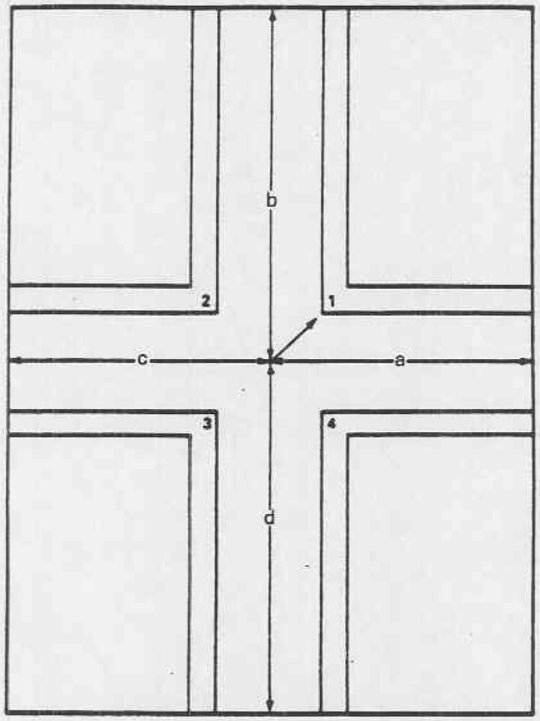
$= 35\frac{7}{16} = \frac{567}{16} \qquad \frac{231}{8} = \frac{27X}{8} - \frac{16X}{8} \qquad \frac{54Y}{16} = \frac{567}{16}\left(\frac{61}{16} - \frac{54}{16}\right)$

$X + Z + Y = 35\frac{7}{16} + 4\frac{19}{32} \qquad \frac{231}{8} \cdot \frac{8}{11} = X \qquad Y = \frac{567}{16} \cdot \frac{7}{16} \cdot \frac{16}{54}$

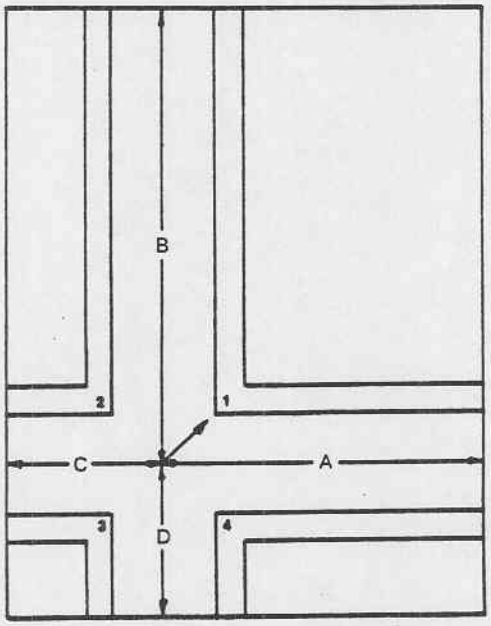
$= 40\frac{1}{32} \qquad X = 21 \qquad Y = 4\frac{19}{32}$

CALCULATION EXAMPLE
Figure 5.11

DETERMINATION OF SID



SPOTFILM X-RAY FIELD LIMITATION, TEST STAND METHOD, REFERENCE
Figure 5.12



SPOTFILM X-RAY FIELD LIMITATION, TEST STAND METHOD, ACTUAL
Figure 5.13

RECORD SHEET

This sheet is to be used by the assembler to assure that all points of compliance are covered. It will also serve as a maintenance log.

HOSPITAL:____________________ ROOM #:____________

DATE OF INSTALLATION:________________ ASSEMBLER:____________

Requirement	Applicable Paragraph	Installation Date	Date	Date	Date	Date
1. Half value layer	XR 8/2.09					
2. Min. field size	XR 8/2.16					
3. X-ray field limitation & alignment	XR 8/2.20					
4. Fluoroscopic X-ray field limitation	XR 8/2.24					
5. Fluoroscopic Source to Skin Distance (SSD)	XR 8/2.25					
6. Primary barrier - X-ray lockout	XR 8/2.27					
7* Alignment of X-Ray edges to selected portions of the image receptor	XR 8/2.29					
8.* Alignment of center of X-ray field to center of selected portion of image receptor	XR 8/2.30					
9. Remote control inspection/cleaning						

(over)

Requirement	Applicable Paragraph	Installation Date	Date	Date	Date	Date
10. Collimator mounting inspection	Section 2 2.3					
11. Electrical cable inspection						
12. SID Monitor inspection	Section 2.5					
INITIALS:						

NOTES:

*Spotfilm Radiographic Tests.

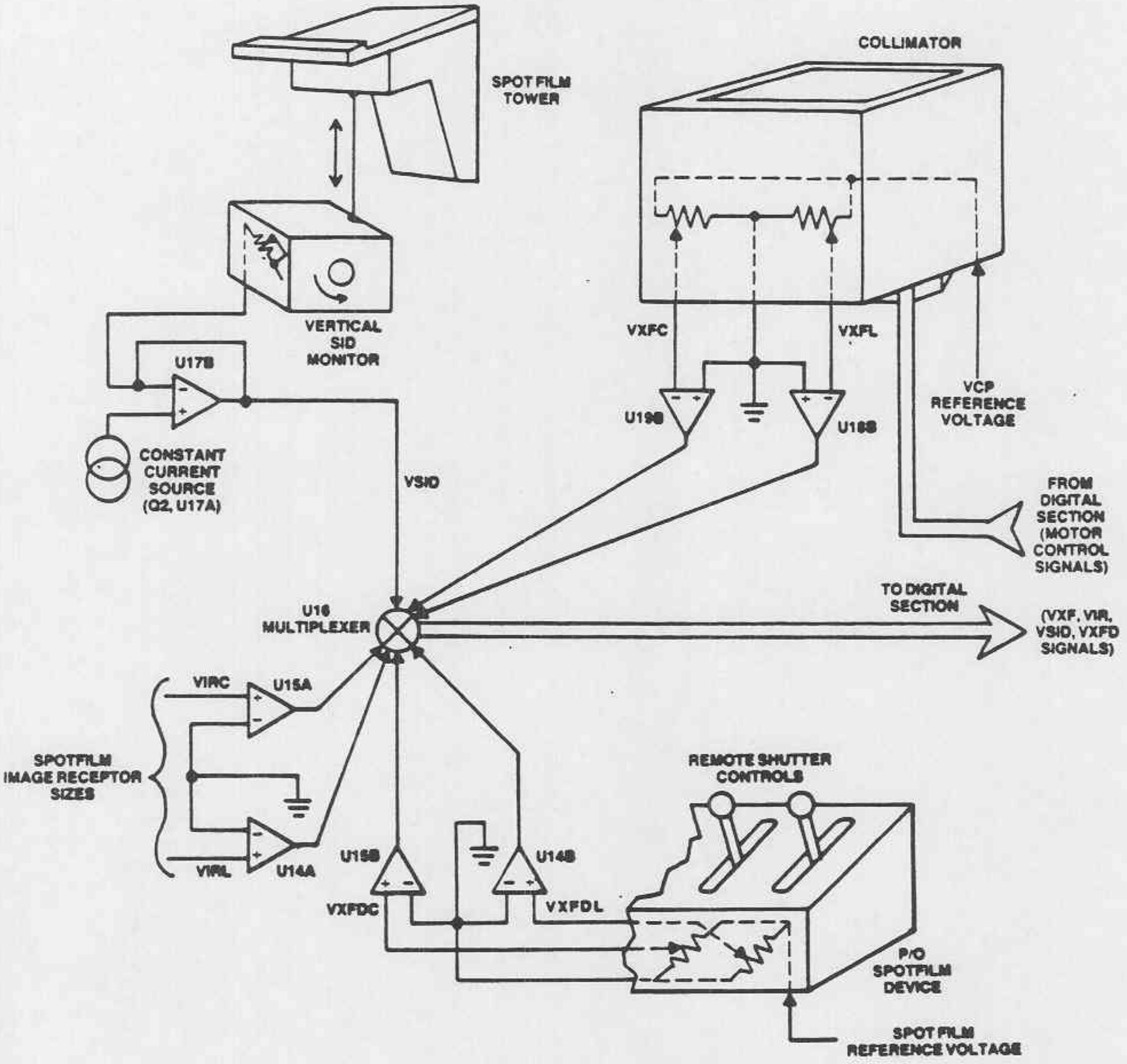
SECTION 6.0

NOT APPLICABLE FOR THIS MANUAL

NO TEXT

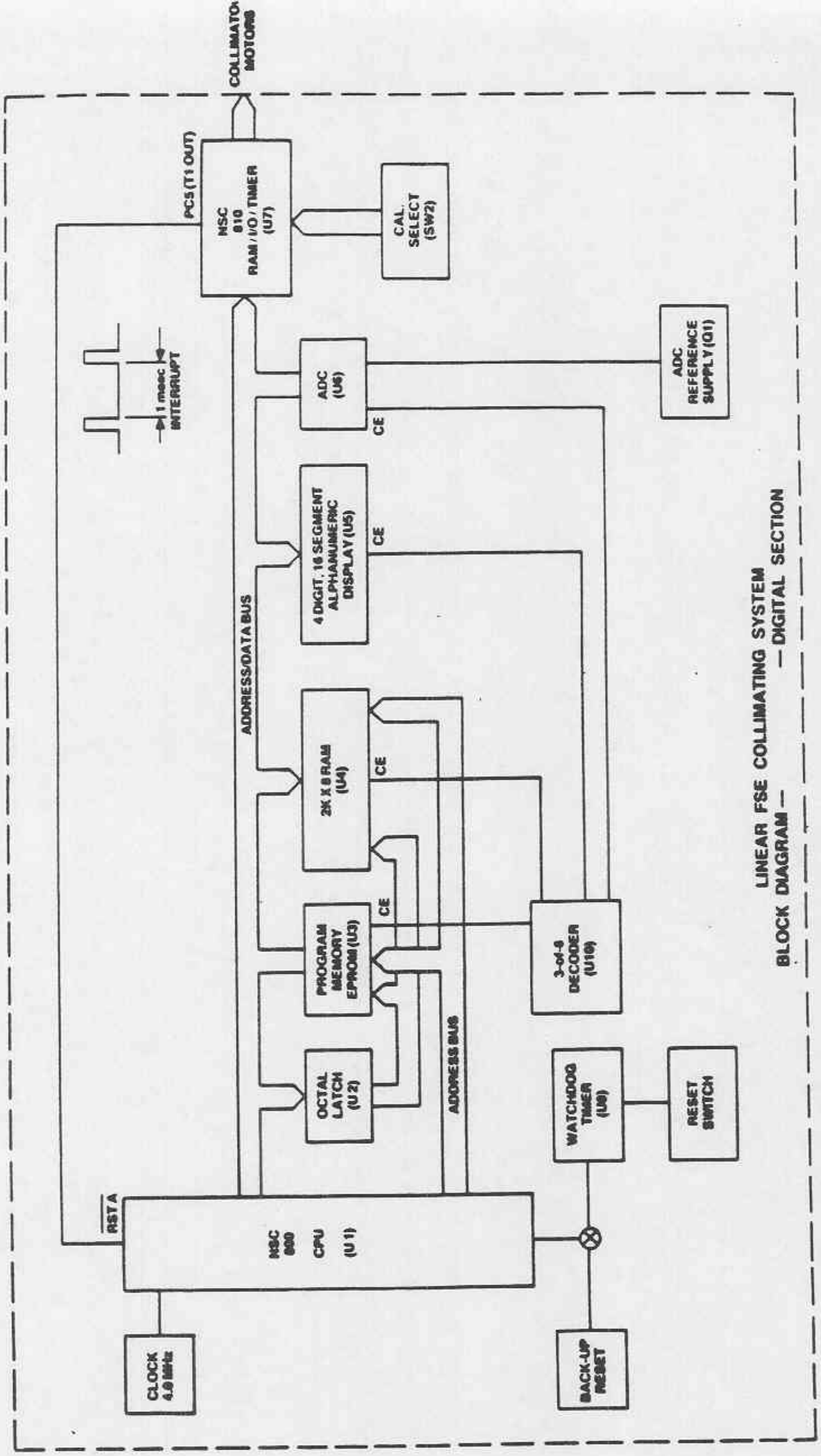
SECTION 7.0

THEORY OF OPERATION


SPOT FILM TOWER
COLLIMATOR
VERTICAL SID MONITOR
U17B
CONSTANT CURRENT SOURCE (Q2, U17A)
VSID
VXFC
VXFL
U19B
U18B
VCP REFERENCE VOLTAGE
FROM DIGITAL SECTION (MOTOR CONTROL SIGNALS)
U16 MULTIPLEXER
TO DIGITAL SECTION
(VXF, VIR, VSID, VXFD SIGNALS)
VIRC
U15A
SPOTFILM IMAGE RECEPTOR SIZES
VIRL
U14A
U15B
U14B
VXFDC
VXFDL
REMOTE SHUTTER CONTROLS
P/O SPOTFILM DEVICE
SPOT FILM REFERENCE VOLTAGE

LINEAR FSE COLLIMATING SYSTEM
BLOCK DIAGRAM — ANALOG SECTION

Figure 7.1


COLLIMATOR MOTORS
PC5 (T1 OUT)
NSC 810 RAM/I/O/TIMER (U7)
CAL. SELECT (SW2)
ADC REFERENCE SUPPLY (Q1)
ADC (U6)
CE
1 msec INTERRUPT
4 DIGIT, 16 SEGMENT ALPHANUMERIC DISPLAY (U5)
CE
ADDRESS/DATA BUS
2K X 8 RAM (U4)
CE
PROGRAM MEMORY EPROM (U3)
CE
OCTAL LATCH (U2)
ADDRESS BUS
3-of-8 DECODER (U10)
WATCHDOG TIMER (U8)
RESET SWITCH
RSTA
NSC 800 CPU (U1)
CLOCK 4.9 MHz
BACK-UP RESET
LINEAR FSE COLLIMATING SYSTEM
BLOCK DIAGRAM — DIGITAL SECTION

BLOCK DIAGRAM, DIGITAL SECTION
Figure 7.2

7.0 THEORY OF OPERATION

7.1 MECHANICAL OPERATION

Eureka Linear FSE Collimators contain two major sets of shutters, long and cross, which define the absolute X-ray field size. There are also two secondary sets of shutters which protrude into the port of the X-ray tube which help reduce the effects of off-focus radiation. The secondary cross shutters are mechanically linked to the primary cross shutters and follow the action of the primary shutters to provide additional reduction of off-focus radiation with smaller X-ray field sizes.

Both shutter mechanisms are geared with anti-backlash mechanisms and coupled to split-phase AC drive motors.

The shutters may be positioned manually with the remote shutter controls on the spotfilm device.

7.2 ELECTRONIC OPERATION

The collimator electronics resides on two printed circuit boards:

- Logic PCB
- FS Driver PCB

For simpler schematic interpretation, the Logic PCB is further divided into two sections:

- Analog Interface
- Digital

The operating system is represented by both analog and digital block diagrams (see Figures 7.1 and 7.2).

NOTE: Refer to Section 8 for definitions.

7.2.1 POWER SUPPLIES -

A 110 VAC to ±15 VDC supply is included to feed various 3-terminal voltage regulator I.C.'s on the logic board. A 24 VAC supply is required. This is wired through a line filter (included), for eventual distribution to the servo motors through TS1 and TS2.

7.2.2 LOGIC BOARD - ANALOG SECTION

(See Schematic 70-08084, Sheet 2)

This section of the logic board provides the digital section with multiplexed analog signals representing image receptor size, SID, and the X-ray field dimensions as selected via the remote shutter controls.

7.2.2.l CONTINUOUS SID CIRCUIT

Constant current source Q2 and its associated circuitry supply current to the continuous SID potentiometer connected through terminals 5 and 18. The voltage developed across the SID pot therefore varies linearly with changes in SID. A temperature compensated I.C. (VR4) produces a stable 1.2 volt reference to the non-inverting input of U17A, an operational amplifier. The output of U17 drives Q2 to produce a drop across potentiometer R52 (Slope Adjust) and R51. Since this voltage is also applied to the inverting input of U17, U17 regulates the bias applied to the base of Q2 to produce a matching, constant 1.2 volt drop across R52 and R51. The output of the constant current source is therefore equal to 1.2V/(R52 + R51). U17B is configured as a noninverting amplifier, the gain of which is determined by a short circuit (unity in the case of SW5 closed) or the resistor selected by SW2-SW4. The voltage at U17-7 is then applied to analog multiplexer U16-4 as the SID scaling voltage (VSID). VSID ensures that the collimator shutters open or close to maintain constant frame size for a given format at all SIDs in the range of the table vertical carriage.

This simplified scaling method (to compensate for various table/spotfilm tower combinations) offers an efficient, economical alternative to separate, mechanically scaled distance monitors.

7.2.2.2 IMAGE RECEPTOR SIZE, REMOTE SHUTTER CONTROL AND COLLIMATOR FEEDBACK CIRCUITS

The voltages representing image receptor size (VIR), remote shutter control setting (VXFD) and collimator feedback (VXF) are fed to differential amplifiers U14A/U15A, U14B/U15B and U18B/U19B, respectively.

These differential amplifiers are used to provide floating, balanced inputs for the outboard potentiometers. This circuitry minimizes noise induced in the sometimes long interconnecting cables between the potentiometers and the logic: by using a separate ground and return line, any common-mode noise induced on the ground and return lines causes a cancelling effect due to differential amplification. Additional amplifiers (U18A and U19A) are provided for control of the collimator feedback voltage offset and gain.

7.2.2.3 ANALOG MULTIPLEXING CIRCUIT

As mentioned earlier in this discussion, U16 is an analog multiplexer. This circuit acts as a switch that sends its seven analog voltages through R10 and R11 to U6-6 (in the digital section) one at a time. The particular voltage sent is determined by a 3-bit address at U16-15, -16, and -1. Each of the analog voltages has a distinct address for each of the seven voltages. So, changing the address changes the voltage that U16 sends to U6. (U6 is an analog-to-digital converter that changes the voltage from U16 to a digital value and applies it to the processor over the data bus.) SW3 is a nine-position rotary switch that allows all of U16's input voltages to be observed at TP6.

7.2.3 LOGIC BOARD - DIGITAL SECTION

(See Schematic Diagram No. 70-08084, Sheet 1)

The microprocessor used in this system, U1, is the National™ NSC800, which combines the low power consumption of CMOS with a 4.0 mHz operating speed. Its 8-bit bi-directional bus is multiplexed for transferring both data and addresses. Address latch U2 latches the addresses and transfers them from its "Q" outputs to the address inputs of EPROM U3, RAM U4 and the 4-digit, 16-segment alphanumeric display U5.

U1 uses U10, a 3-of-8 decoder, to gain access to all of the I.C.s on the bus, with the exception of U2. This is accomplished by applying a 3-bit address to U10-1, -2, and -3. U10 then decodes the address and applies it to the CE (chip enable) or CS (chip select) input of the selected circuit, enabling it.

Approximately 4k (8 x 4096 = 32,768 bits) of EPROM U3 is used to store the software that controls the operation of the processor. Therefore, when U1 receives data from U6, it processes it under the direction of the program in U3 and temporarily stores the variables that it generates in RAM U4.

U5 is an alphanumeric display that is useful during troubleshooting because it can display the digital value of all collimator control voltages. The actual voltage displayed is determined by the setting of rotary switch SW2.

U9, a "watchdog" timer, provides a reset pulse of 50 milliseconds to U1. Additionally, it monitors the power supply and issues a reset if the voltage drops below 4.5 volts, and also monitors U1 by way of U7: if periodic pulses (indicating normal operation) are not received every 150 milliseconds, the reset is again generated. The timer can be disabled and substituted by a simple R/C network (R3, C8) that provides an alternate source of Power On Reset when the W1 jumper is connected appropriately.

U7 is an I/O port that sends the data computed by U1 to the collimator shutter motors. These stepper motors then open or close the shutters, as needed.

Several circuits are also used to supply operating voltages required by the circuit board. VR5 and associated components converts +15 VDC to regulated +5 VDC for the microprocessor. VR6 and VR7 are +15 VDC-to-regulated +10 VDC 3-terminal regulators for the spotfilm and collimator potentiometer reference voltages, respectively. VR2 and VR3 produce a source of ± 1.2 VDC for the collimator feedback offset voltages and are used for calibration.

Q1 and associated circuitry act to convert +15 VDC to regulated +5 VDC for U6. This circuit is needed because U6 has high current requirements.

7.2.4 FS DRIVER BOARD

(See Schematic 70-08083, Sheet 1)

Commands are routed to this board via U8, a high current darlington array on the logic PCB. IC1-IC6 are triac driver opto couplers, which not only selectively turn on triacs Q1-Q6, but isolate the outputs from the inputs at J1-2, -4, -15 and -16. C1 and C11 are the phase-shift capacitors for the CROSS and LONG circuits, respectively. When a motor is turning, one phase winding is on, while the other is OFF. For example, if a CROSS OPEN command is received, Q1 and Q2 are turned on. C1, which sits across the two windings, is connected and 24 VAC is routed through Q1 to one winding. When a CROSS CLOSE command is received, Q2 is again turned on, but so is Q3, connecting the 24 VAC to the other side of C1 and to the other winding. C3, C4 and C6 prevent false triggering, and snubber networks formed by C2 and RP1 prevent reactive load damage to the triac drivers.

NO TEXT

SECTION 8.0

APPENDIX

DEFINITIONS

SID	Source to Image Distance
VSID	Voltage representing SID.
VCSID	Voltage representing Continuous SID.
XF	X-ray Field.
VXFC	Voltage at the Collimator Feedback Potentiometer Wiper representing the X-ray Field in the Cross Dimension.
VXFL	Voltage at the Collimator Feedback Potentiometer Wiper representing the X-ray Field in the Long Dimension.
IR	Image Receptor (Cassette Tray).
VIRC	Voltage from the Cassette Sensing Element representing the Image Receptor size in the Cross Dimension.
VIRL	Voltage from the Cassette Sensing Element representing the Image Receptor size in the Long Dimension.
VCP	Voltage applied to the Collimator Potentiometers.
VXFDC	Voltage representing the X-ray Field Desired in the Cross Dimension.
VXFDL	Voltage representing the X-Ray Field Desired in the Long Dimension.
I.I.	Image Intensifier

TUBE MOUNTING INFORMATION
TABLE 8-1

The following list is intended to help the installer determine mounting information only, and does not imply compatibility. See Section 1 for compatibility information.

MANUFACTURER	TUBE HOUSING	FOCAL SPOT TO PORT MOUNTING	DISTANCE TO COLLIMATOR MOUNTING FLANGE	
Eureka	Emerald Series	2-1/16"	3/8"	(.375)
	Diamond Series	2-1/16"	3/8"	(.375)
	Sapphire Series	2-3/16"	1/4"	(.250)
Eimac	B100	2-17/64"	11/64"	(.171)
	B150	2-11/64"	17/64"	(.265)
General Electric	Maxiray 100	2-5/16"	1/8"	(.125)
	HRT, MX75	2-1/16"	3/8"	(.375)
Picker/Dunlee	DU-140	2-1/16"	3/8"	(.375)
	DU-200	2-1/16"	3/8"	(.375)
	DU-300	2-9/32"	5/32"	(.156)
	PX-400	2-5/16"	1/8"	(.125)
Machlett	DX40 Series	2-1/16"	3/8"	(.375)
	DX50 Series	2-3/16"	1/4"	(.250)
	DX60 Series	2-5/16"	1/8"	(.125)
	DX70 Series	2-5/16"	1/8"	(.125)

NO TEXT

SECTION 9.0

BILLS OF MATERIAL AND SCHEMATICS

NO TEXT

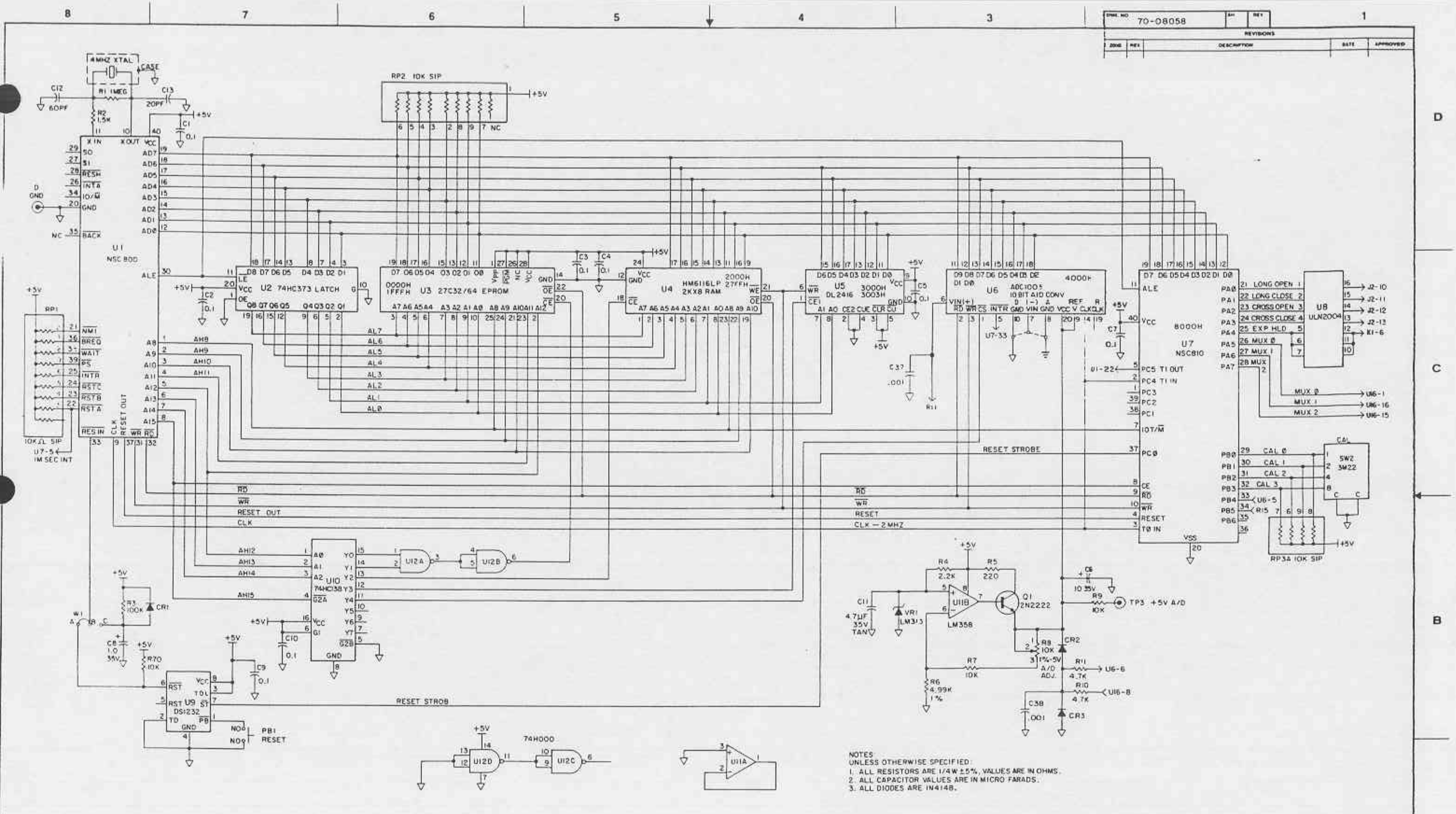
BILL OF MATERIALS
UNDERTABLE LOGIC PCB ASSEMBLY
70-08084

Item No.	Ref. Design	Part No.	Description	Vendor Part No.
1		70-06274	Undertable Logic PCB	
2	U9	70-03121	I.C. 8 Pin DIP, Micro Monitor	DS1232
3	U1	70-03127	I.C. 40 Pin DIP, Microprocessor	NSC800
4	U7	70-03126	I.C. 40 Pin DIP, Ram-I/O-Timer	NSC810
5	U3	70-08075	I.C. U.T. Programmed EPROM 28 Pin	27C32/64
6	U4	70-03130	I.C. 24 Pin DIP, 2K X 8 RAM	HM6116LP
7	U2	70-03124	I.C. 24 Pin DIP, Latch	74HC373
8	U10	70-03128	I.C. 16 Pin DIP, Line Decoder	74HC138
9	U5	70-03068	I.C. 18 Pin DIP, Intel Display	DL2416
10	U14, U15, U18, U19	70-03355	I.C. 8 Pin DIP, Dual Low Power Amp.	LF442CN
11	U6	70-03122	I.C. 20 Pin DIP, 10 Bit A/D Conv.	ADC1005
12	U16	70-03125	I.C. 16 Pin DIP, Analog Multiplexer	DG508
13	U12	70-03131	I.C. 14 Pin DIP, 2 Input Nand Gate	74HC00
14	U11, 17	70-03351	I.C. 8 Pin DIP	LM358
15	K1	70-04014	Relay	LZNQ2-US
16	PB1	70-04252	Switch, Pushbutton	
17	TZ3	70-03070	Suppressor, Trans. Silicon	1.5KE120CA
18	TZ1, 2	70-03069	Suppressor, Trans. Voltage	MPT-15
19	TZ4	70-03071	Suppressor, Trans. Voltage	MPT-5
20	SW3	70-04264	Switch, Thumbwheel Decimal	3M12
21	SW2	70-04265	Switch, Thumbwheel BCD	3M22
22	CR1, 2, 3, 6-19	70-03001	Diode	1N4148
23	XTAL1	70-03129	Crystal	
24	VR1, 2, 3, 4	70-03301	Regulator, Voltage	LM113
25	CR 4, 5, 20-24	70-03012	Diode	1N4004
26	Q1	70-03402	Transistor	2N2222
27	LED 1-5	70-03061	LED, RED	
28	VR5	70-03303	Regulator, Voltage	7805
29	VR6, 7	70-03302	Regulator, Voltage	LM317
30	VR8	70-03021	Regulator, Volt. 4.7V	1N750
31	Q2	70-03401	Transistor	2N2905
32	C32	70-02503	Capacitor, Electrolytic,100 mF, 16V	
33	C1-5, 7, 9, 10, 35, 36	70-02010	Capacitor, 0.1 mF, 50V	
34	C12	70-02023	Capacitor, 62 pF	
35	C13	70-02022	Capacitor, 20 pF	
36	C28	70-02509	Capacitor, Tant. 2.2 mF, 35V	
37	C6, 21-23, 25-27, 30, 31	70-02511	Capacitor, Tant. 10 mF, 35V	
38	C11, 33, 34	70-02514	Capacitor, Tant. 4.7 mF, 35V	

UNDERTABLE LOGIC PCB ASSEMBLY
70-08084
Table 9-1

Item No.	Ref. Design	Part No.	Description	Vendor Part No.
39	C8	70-02024	Capacitor, Tant. 1.0 mF, 35V	
40	C24, 29	70-02012	Capacitor, .01 mF, 100V	
41	R16	70-00042	Resistor, Carb. Film, 1/4W, 1KΩ, ±5%	
42	R9, 15, 39, 40 50, 53, 65, 70	70-00064	Resistor, Carb. Film, 1/4W, 10KΩ, ± 5%	
43	R3	70-00086	Resistor, Carb. Film, 1/4W, 100KΩ, ±5%	
44	R4, 47-49	70-00048	Resistor, Carb. Film, 1/4W, 2.2KΩ, ±5%	
45	R5, R44, R58	70-00026	Resistor, Carb. Film, 1/4W, 220Ω, ±5%	
46	R10, 11	70-00056	Resistor, Carb. Film, 1/4W, 4.7KΩ, ±5%	
47	R14, 45, 59	70-00044	Resistor, Carb. Film, 1/4W, 1.2KΩ, ±5%	
48	R51	70-00010	Resistor, Carb. Film, 1/4W, 47Ω, ±5%	
49	R36, 43	70-00060	Resistor, Carb. Film, 1/4W, 6.8KΩ, ±5%	
50	R1	70-00108	Resistor, Carb. Film, 1/4W, 1MΩ, ±5%	
51	R2	70-00045	Resistor, Carb. Film, 1/4W, 1.5KΩ, ±5%	
52	R6, 57, 67	70-00314	Resistor, Metal Film, 4.99KΩ, ±1%	
53	R7, R68	70-00700-5	Resistor, Metal Film, 10KΩ, ±1%	
54	R69	70-00318	Resistor, Metal Film, 15KΩ, ±1%	
55	R17-34, 55, 56, 61-64	70-00700-7	Resistor, Metal Film, 100KΩ, ± 1%	
56	RP4	70-00509	Resistor Array, 6 Pin SIP, 1.2KΩ, ±5%	
57	RP1, 2, 3	70-00510	Resistor Array, 10 Pin SIP, 10KΩ, ±5%	
58	R60, 46	70-00653-2	Potentiometer, 25T, 1KΩ	
59	R52, 66	70-00653-1	Potentiometer, 25T, 500Ω	
60	R37, 41	70-00653-3	Potentiometer, 25T, 5KΩ	
61	R8, 38, 42	70-00653-7	Potentiometer, 25T, 10KΩ	
62	TP1, 3-6	70-04595	Test Point	
63	U3	70-04219	Socket, 28 Pin DIP	
64	U5	70-04586	Socket, Terminal Strip	
65	U8	70-03021	I.C. 16 Pin DIP Transistor Array	ULN2004
66	J1	70-04521	Terminal Strip, 22 Position	
67	J2	70-04535	Header, Terminal, 15 Pin	
68	SW1	70-04202	Switch, 10 Pin DIP, 5 Position	
69		70-04710	Heat Sink	Wakefield 289
70		70-10982	Screw, 6-32 x 1/2 Slotted PHMS	
71		70-10815	Nut, 6-32	
72	C37, C38	70-02030	Capacitor, .001 mF, 200 WVDC	

UNDERTABLE LOGIC PCB ASSEMBLY
70-08084
Table 9-1 (Cont.)


DWG NO 70-08058
REVISIONS
ZONE REV DESCRIPTION DATE APPROVED
4MHZ XTAL
CASE
C12 60PF
R1 1MEG
C13 20PF
R2 1.5K
C1 0.1
+5V
X IN
X OUT
VCC
SO
SI
RESH
INTA
IO/M
GND
BACK
D GND
NC
U1 NSC 800
AD7
AD6
AD5
AD4
AD3
AD2
AD1
AD0
ALE
A8
A9
A10
A11
A12
A13
A14
A15
RESET OUT
CLK
RD
WR
RES IN
NMI
BREQ
WAIT
PS
INTR
RSTC
RSTB
RSTA
RP1
10KΩ SIP
U7-5 1M SEC INT
RP2 10K SIP
NC
U2 74HC373 LATCH
LE
OE
C2 0.1
U3 27C32/64 EPROM
0000H
1FFFH
VPP
PGM
C3 0.1
C4 0.1
OE
CE
U4 HM6116LP 2KX8 RAM
2000H
27FFH
WE
U5 DL2416
3000H
3003H
C5 0.1
CUE CLR CU
U6 ADC1005 10 BIT A/D CONV
4000H
VIN(+)
VIN(-)
REF
U7-33
C37 .001
R11
U7 NSC810
8000H
TI OUT
TI IN
IOT/M
RESET STROBE
PC0
CE
RD
WR
RESET
T0 IN
VSS
C7 0.1
U1-22
PA0
PA1
PA2
PA3
PA4
PA5
PA6
PA7
LONG OPEN
LONG CLOSE
CROSS OPEN
CROSS CLOSE
EXP HLD
MUX Ø
MUX 1
MUX 2
U8 ULN2004
J2-10
J2-11
J2-12
J2-13
K1-6
U16-1
U16-16
U16-15
PB0
PB1
PB2
PB3
PB4
PB5
PB6
CAL Ø
CAL 1
CAL 2
CAL 3
U6-5
R15
CAL
SW2 3M22
RP3A 10K SIP
AL7
AL6
AL5
AL4
AL3
AL2
AL1
ALØ
AH8
AH9
AH10
AH11
AH12
AH13
AH14
AH15
RESET OUT
CLK
CLK — 2 MHZ
U10 74HC138
G2A
G2B
G1
C10 0.1
U12A
U12B
U12C
U12D
74H000
+5V
R3 100K
CR1
W1
C8 1.0 35V
R70 10K
U9 DS1232
RST
TOL
ST
TD
PB
GND
C9 0.1
NO
PB1 RESET
RESET STROB
U11A
U11B LM358
R4 2.2K
R5 220
Q1 2N2222
C11 4.7µF 35V TAN
VR1 LM313
R6 4.99K 1%
R7 10K
R8 10K
+5V A/D ADJ.
CR2
C6 10 35V
R9 10K
TP3 +5V A/D
R11 4.7K
U6-6
R10 4.7K
U16-8
C38 .001
CR3

NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE 1/4W ±5%, VALUES ARE IN OHMS.
2. ALL CAPACITOR VALUES ARE IN MICRO FARADS.
3. ALL DIODES ARE IN4148.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE
FRACTIONS DECIMALS ANGLES
MATERIAL
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APPROVALS DATE
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EUREKA X-RAY TUBE

UNDERTABLE LOGIC PCB
DIGITAL SCHEMATIC

Figure 9.1
Page 9-5

SIZE D ITEM CLASS AE DWG NO 70-08084 REV B
SCALE SHEET 1 OF 3

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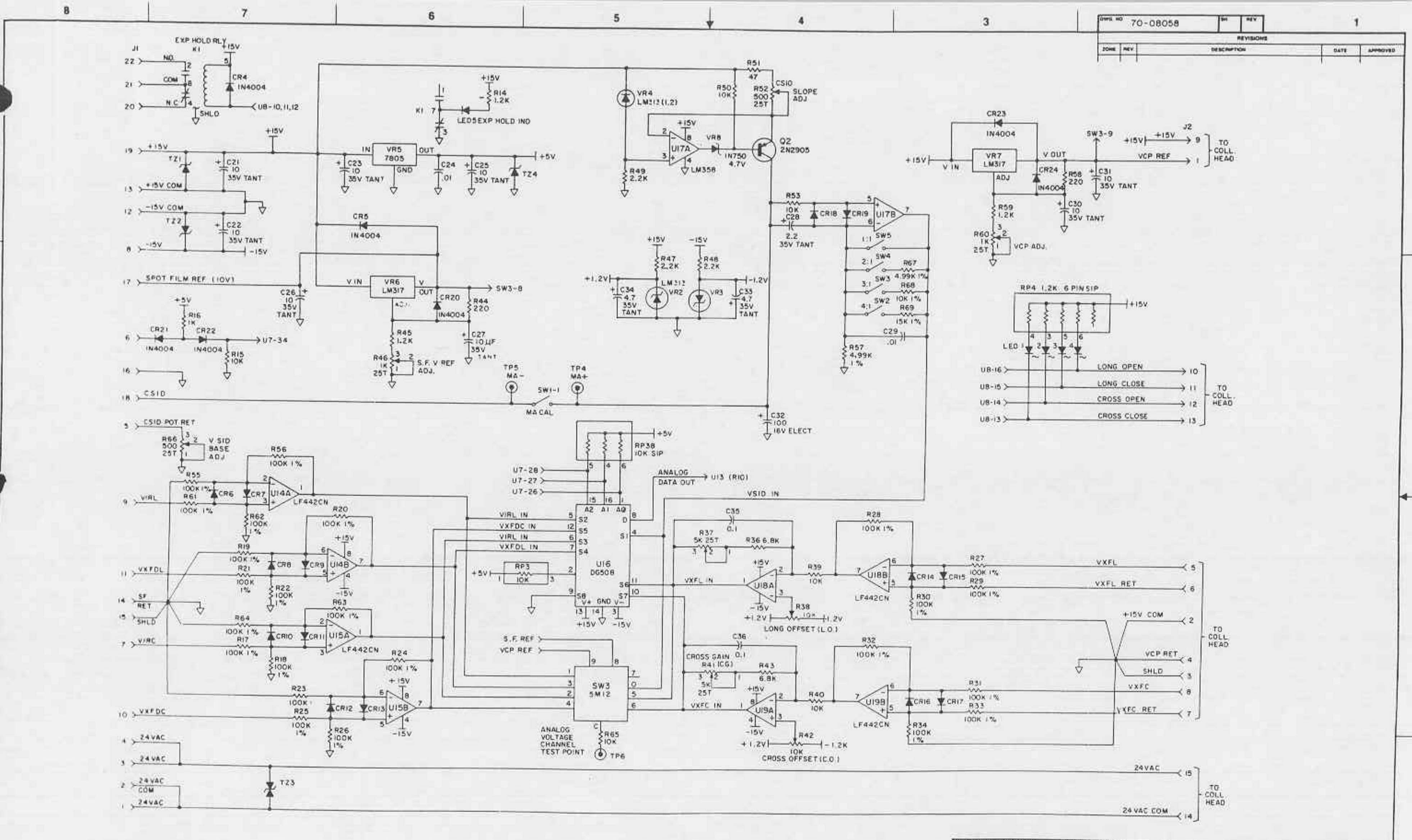
70-08058
REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
J1
EXP HOLD RLY
K1
+15V
NO
COM
N.C
SHLD
CR4
1N4004
U8-10,11,12
+15V
TZ1
C21 10 35V TANT
+15V COM
-15V COM
TZ2
C22 10 35V TANT
-15V
SPOT FILM REF (10V)
+5V
R16 1K
CR21 1N4004
CR22 1N4004
R15 10K
U7-34
CSID
CSID POT RET
R66 500 25T
V SID BASE ADJ
VR5 7805
IN
OUT
GND
C23 10 35V TANT
C24 .01
C25 10 35V TANT
TZ4
+5V
R14 1.2K
LED5 EXP HOLD IND
CR5 1N4004
VR6 LM317
V IN
ADJ
CR20 1N4004
R44 220
SW3-8
C26 10 35V TANT
R45 1.2K
R46 1K 25T
S.F. V REF ADJ.
C27 10µF 35V TANT
TP5 MA-
TP4 MA+
SW1-1
MA CAL
VR4 LM312 (1.2)
U17A
LM358
VR8
1N750 4.7V
R49 2.2K
R50 10K
R51 47
R52 500 25T
C510
SLOPE ADJ
Q2 2N2905
+1.2V
-1.2V
R47 2.2K
R48 2.2K
LM313
VR2
VR3
C34 4.7 35V TANT
C33 4.7 35V TANT
R53 10K
C28 2.2 35V TANT
CR18
CR19
U17B
SW5 1:1
SW4 2:1
SW3 3:1
SW2 4:1
R67 4.99K 1%
R68 10K 1%
R69 15K 1%
C29 .01
R57 4.99K 1%
C32 100 16V ELECT
CR23 1N4004
VR7 LM317
V OUT
VCP REF
CR24 1N4004
R58 220
C31 10 35V TANT
C30 10 35V TANT
R59 1.2K
R60 1K 25T
VCP ADJ.
SW3-9
J2
TO COLL. HEAD
RP4 1.2K 6 PIN SIP
LED 1
U8-16
U8-15
U8-14
U8-13
LONG OPEN
LONG CLOSE
CROSS OPEN
CROSS CLOSE
RP38 10K SIP
U7-28
U7-27
U7-26
ANALOG DATA OUT
U13 (R10)
VSID IN
U16 DG508
VIRL IN
VXFDC IN
VIRL IN
VXFDL IN
RP3 10K
S.F. REF
VCP REF
SW3 SM12
ANALOG VOLTAGE CHANNEL TEST POINT
R65 10K
TP6
VIRL
R55 100K 1%
R61 100K 1%
CR6
CR7
U14A
LF442CN
R56 100K 1%
R62 100K 1%
VXFDL
R19 100K 1%
R21 100K 1%
CR8
CR9
U14B
R20 100K 1%
R22 100K 1%
SF RET
SHLD
VIRC
R64 100K 1%
R17 100K 1%
CR10
CR11
U15A
R63 100K 1%
R18 100K 1%
VXFDC
R23 100K
R25 100K 1%
CR12
CR13
U15B
R24 100K 1%
R26 100K 1%
24VAC
24VAC COM
TZ3
C35 0.1
R37 5K 25T
R36 6.8K
VXFL IN
U18A
R39 10K
R38 10K
LONG OFFSET (L.O.)
U18B
R28 100K 1%
CR14
CR15
R27 100K 1%
R29 100K 1%
R30 100K 1%
VXFL
VXFL RET
+15V COM
VCP RET
SHLD
VXFC
VXFC RET
C36 0.1
CROSS GAIN R41 (CG) 5K 25T
R43 6.8K
VXFC IN
U19A
R40 10K
R42 10K
CROSS OFFSET (C.O.)
U19B
R32 100K 1%
CR16
CR17
R31 100K 1%
R33 100K 1%
R34 100K 1%
24VAC
24 VAC COM

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TOLERANCES ARE
FRACTIONS DECIMALS ANGLES

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ISSUED	

EUREKA X-RAY TUBE

UNDERTABLE LOGIC PCB
ANALOG SCHEMATIC

Figure 9.2
Page 9-6

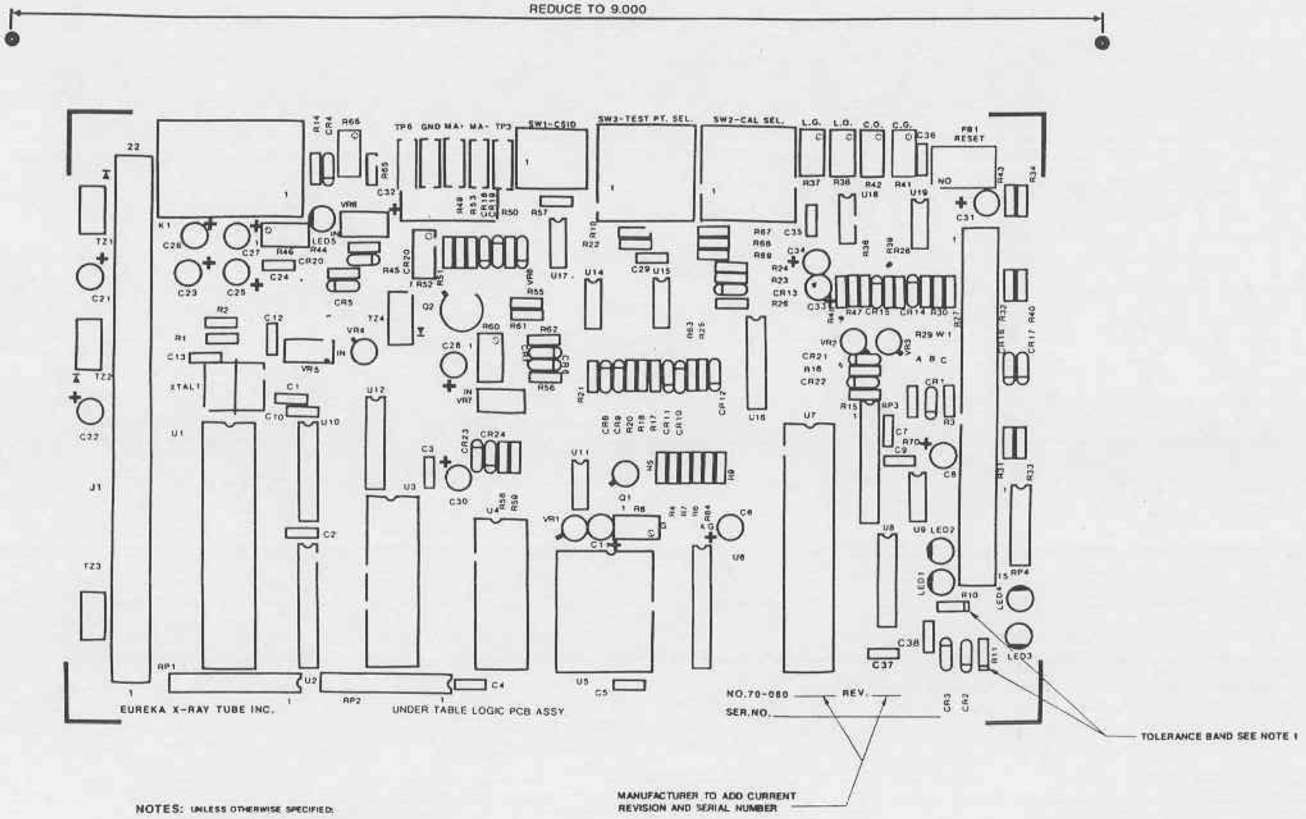
SIZE	ITEM CLASS	DWG NO	REV
D		70-08084	B

SCALE
SHEET 2 OF 3

DWG NO

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED


REDUCE TO 9.000
TP6 GND MA+ MA- TP3
SW1-CSID
SW3-TEST PT. SEL.
SW2-CAL SEL.
L.G.
L.O.
C.O.
C.G.
FB1 RESET
NO
K1
VR1
VR2
VR3
VR4
VR5
VR6
VR7
VR8
XTAL1
J1
TZ1
TZ2
TZ3
TZ4
Q1
Q2
LED1
LED2
LED3
LED4
LED5
U1
U2
U3
U4
U5
U6
U7
U8
U9
U10
U11
U12
U14
U15
U16
U17
U18
U19
RP1
RP2
RP3
RP4
A B C
EUREKA X-RAY TUBE INC.
UNDER TABLE LOGIC PCB ASSY
NO.70-080 ____ REV. ____
SER.NO. ____

TOLERANCE BAND SEE NOTE 1

MANUFACTURER TO ADD CURRENT REVISION AND SERIAL NUMBER

NOTES: UNLESS OTHERWISE SPECIFIED:

1. ALL COLOR CODED RESISTORS TO BE INSERTED WITH TOLERANCE BAND TOWARD BOTTOM OR RIGHT HAND SIDE OF PCB.
2. ALL CAPACITORS, DIODES ETC. TO BE INSERTED WITH VALUE AND/OR TYPE VISIBLE WHEN LOOKING DOWN ON COMPONENT SIDE OF PCB.
3. BRUSH CONFORMAL COAT BOTH SIDES WITH SR 900 SILICONE (G.E.). REFER TO INSRUCTIONS FOR USE AND MATERIAL SAFTY DATA SHEET ON FILE WITH EUREKA FACILITY DEPT.

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TOLERANCES ARE
FRACTIONS DECIMALS ANGLES
± .XX ± ±
.XXX ±

MATERIAL

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ORIGINAL PRODUCT
5041

APPROVALS	DATE
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CHECKED	
ISSUED	

EUREKA X-RAY TUBE CO.
Litton

UNDERTABLE LOGIC PCB
ASSEMBLY DRAWING

Figure 9.3
Page 9-7

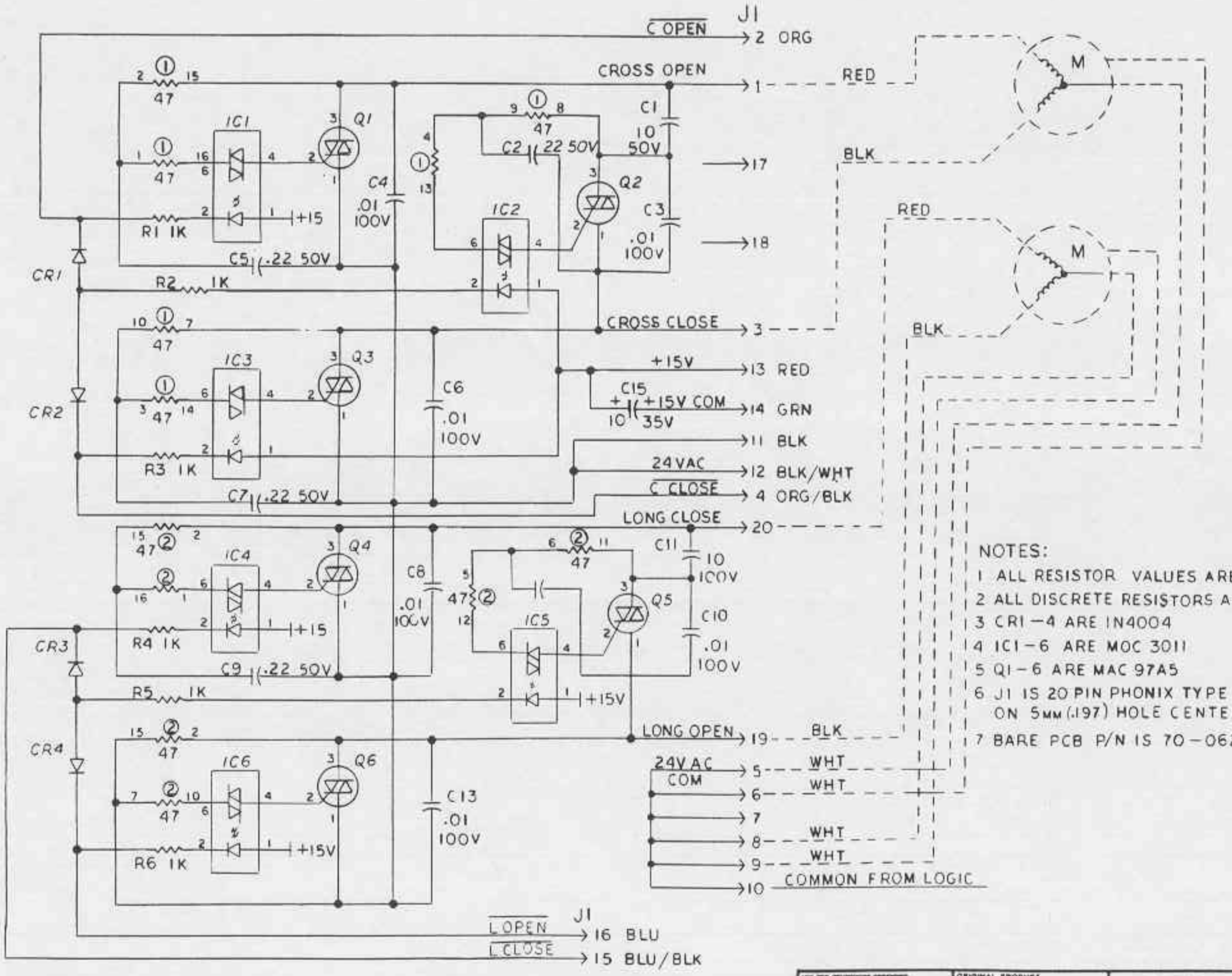
SIZE D
ITEM CLASS
DWG NO 70-08084
REV B
SCALE
SHEET 3 OF 3

BILL OF MATERIALS
FSE DRIVER PCB ASSEMBLY
70-08083

Item No.	Ref. Design	Part No.	Description	Vendor Part No.
1		70-06273	FS Driver PCB	
2	1C1-6	70-03043	Opto Coupler/Isolator, 6 Pin DIP	MOC 3011
3	Q1-6	70-03052	Triac	MAC97A5
4	RP1, 2	70-00508	Resistor Array, 16 Pin DIP 47Ω	
5	C15	70-02511	Capacitor, Tant. 10 mF, 35V	
6	C1, 11	70-02101	Capacitor, Non-Pol, 10mF, 50V	
7	C3, 4, 6, 8 10, 13	70-02012	Capacitor, .01mF, 100VDC	
8	C2, 5, 7, 9, 12, 14	70-02021	Capacitor, 0.22mF, 50VDC	
9	R1-6	70-00042	Resistor, Carb. Film, 1/4W, 1KΩ, ±5%	
10	CR1-4	70-03012	Diode, 1 AMP, 200V	1N 4002
11	J1	70-04553	Vertical Socket - 20 Pin	

FSE DRIVER PCB ASSEMBLY
70-08083
Table 9-2

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



J1
C OPEN → 2 ORG
CROSS OPEN → 1
RED
BLK
M
M
RED
BLK
→ 17
→ 18
CROSS CLOSE → 3
+15V → 13 RED
+15V COM → 14 GRN
→ 11 BLK
24VAC → 12 BLK/WHT
C CLOSE → 4 ORG/BLK
LONG CLOSE → 20
LONG OPEN → 19 BLK
24V AC COM → 5 WHT
→ 6 WHT
→ 7
→ 8 WHT
→ 9 WHT
→ 10 COMMON FROM LOGIC
L OPEN → 16 BLU
L CLOSE → 15 BLU/BLK
Q1
Q2
Q3
Q4
Q5
Q6
IC1
IC2
IC3
IC4
IC5
IC6
CR1
CR2
CR3
CR4
R1 1K
R2 1K
R3 1K
R4 1K
R5 1K
R6 1K
47
C1 10 50V
C2 .22 50V
C3 .01 100V
C4 .01 100V
C5 .22 50V
C6 .01 100V
C7 .22 50V
C8 .01 100V
C9 .22 50V
C10 .01 100V
C11 10 100V
C13 .01 100V
C15 10 35V
+15
+15V

NOTES:

1. ALL RESISTOR VALUES ARE IN OHMS
2. ALL DISCRETE RESISTORS ARE 1/4 W, ±5%
3. CR1 – 4 ARE 1N4004
4. IC1 – 6 ARE MOC 3011
5. Q1 – 6 ARE MAC 97A5
6. J1 IS 20 PIN PHONIX TYPE CONNECTOR ON 5MM (.197) HOLE CENTERS
7. BARE PCB P/N IS 70 – 06273

Linear FSE (DPSC) Collimator

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FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±
MATERIAL
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ORIGINAL PRODUCT DPSC
APPROVALS | DATE
DRAWN REDRAWN R Paleiza 6-15-90
CHECKED
ISSUED

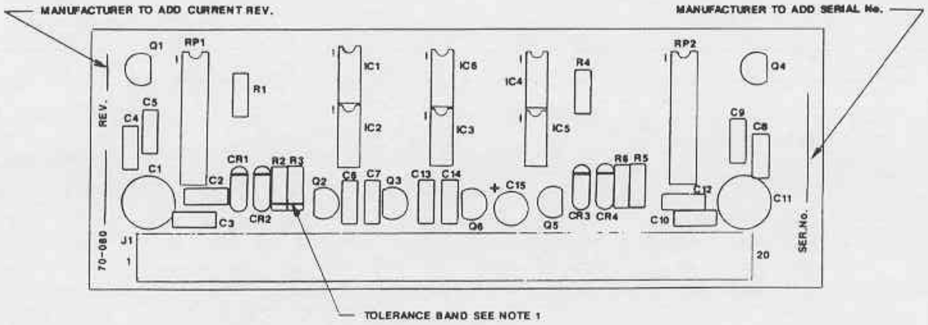
EUREKA X-RAY TUBE

FSE DRIVER PCB
ASSEMBLY SCHEMATIC

Figure 9.4
Page 9-10

SIZE C
ITEM CLASS
DWG NO 70-08083
REV A
SCALE
SHEET 1 OF 2

ZONE	REV	DESCRIPTION	DATE	APPROVED


MANUFACTURER TO ADD CURRENT REV.
MANUFACTURER TO ADD SERIAL No.
REV.
70-080
SER.No.
Q1
RP1
R1
IC1
IC2
IC6
IC3
IC4
IC5
R4
RP2
Q4
C5
C4
C1
C2
C3
CR1
CR2
R2 R3
Q2
C6
C7
Q3
C13
C14
Q6
+
C15
Q5
CR3
CR4
R6 R5
C12
C10
C11
C9
C8
J1
1
20
TOLERANCE BAND SEE NOTE 1

NOTES: UNLESS OTHERWISE SPECIFIED:

1. ALL COLOR CODED RESISTORS TO BE INSERTED WITH TOLERANCE BAND TOWARD BOTTOM OR RIGHT HAND SIDE OF PCB
2. ALL CAPACITORS, DIODES ETC. TO BE INSERTED WITH VALUE, POLARITY AND/OR TYPE VISIBLE WHEN LOOKING DOWN ON COMPONENT SIDE OF PCB.

DWG NO 70-08093 | SH 2 | REV A

Linear FSE (DPSC) Collimator

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DIMENSIONS ARE IN INCHES
TOLERANCES ARE
FRACTIONS ± DECIMALS .XX .XXX ANGLES ±
MATERIAL
FINISH
DO NOT SCALE DRAWING

ORIGINAL PRODUCT DPSC

APPROVALS	DATE
DRAWN R PALAZZO	6 13 7?
CHECKED	
ISSUED	

EUREKA X-RAY TUBE

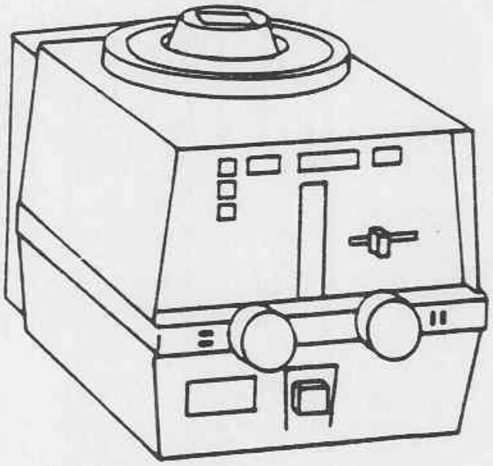
FSE DRIVER PCB
ASSEMBLY

Figure 9.5
Page 9-11

SIZE C | ITEM CLASS | DWG NO 70-08083 | REV A
SCALE | SHEET 2 of 2

CHAPTER 12

OVER-TABLE COLLIMATOR



EUREKA

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Arlington Heights, IL 60004

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(800) 545-3126
FAX (708) 394-5903
TWX (910) 221-5632

LINEAR™ II (DPSC) Collimator

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00-02-1410

TABLE OF CONTENTS

SECTION PAGE

1.0 INTRODUCTION...1-3

1.1 You Have Legal Obligations.......................................1-3
1.2 Background...1-3
1.3 Collimator Features..1-4
1.4 Standard Features..1-4
1.5 Advanced Features..1-5
1.6 Technically Advanced Features......................................1-5
1.7 Specifications...1-5
1.8 Radiation and Mechanical/Electrical Warning........................1-6
1.9 Compatibility..1-7
1.10 Maintenance...1-7
1.11 Compliance Requirements...1-7

2.0 INSTALLATION...2-2

2.1 Unpacking..2-3
2.2 Equipment Supplied...2-3
2.3 Collimator Mounting..2-3
2.4 Power Chassis Mounting...2-3
2.5 Interconnect Wiring..2-4

3.0 OPERATIONAL CHECKOUT PROCEDURE..........3-3

3.1 Collimator Cover Removal...3-2
3.2 Collimator Tilt Switch Checkout....................................3-3
3.3 Table Tilt Switch Checkout (Tilting Tables Only)...................3-4
3.4 Logic and Collimator Operation Checkout............................3-4
3.5 External SID Signal Checkout (Horizontal)..........................3-5
3.6 Tilt Table Receptor SID Signal Checkout............................3-6
3.7 External IR Signals Checkout.......................................3-6
3.8 External IR Signals Checkout For Tilting Tables....................3-7
3.9 Stereo/Tomo Bypass Signal Checkout.................................3-7
3.10 Input Signal Verification Chart...................................3-8
3.11 Input Final Test Switch Settings...................................3-8

4.0 ADJUSTMENT PROCEDURE.............................4-2

4.1 Light Field/X-Ray Field Congruence Test............................4-2
4.2 40" SID Adjustment...4-3
4.3 Collimator Feedback Linearity Test.................................4-4
4.4 72" SID Adjustment...4-5
4.5 Cassette Tray Adjustment...4-5

SECTION PAGE

5.0 ALIGNMENT PROCEDURES 5-3

5.1 Field Projection Lamp and Mirror Adjustment 5-3
5.2 Cross Hair Window Adjustment 5-3
5.3 Bucky Centering Light-line Adjustment 5-3
5.4 Collimator Potentiometer Voltage Adjustment 5-4

6.0 COMPLIANCE VERIFICATION 6-3

6.1 Verification Tests to be Performed 6-3
XR8-2.14 Visual Definition of X-Ray Light Field 6-5
XR8-2.15 Intensity of Light Field Illumination 6-9
XR8-2.16 Minimum Field Size 6-10
XR8-2.17 X-Ray Field/Receptor Center Alignment 6-12
XR8-2.18 Indication of Field Size 6-12
XR8-2.19 POSITIVE BEAM LIMITATION (PBL) 6-13
XR8-2.20 X-ray Field Limitation and Alignment 6-14
XR8-2.21 Return to PBL with IR Change 6-16
XR8-2.22 Keylock PBL Override 6-16
XR8-2.09 Determination of Half Value Layer 6-17

7.0 NOT APPLICABLE FOR THIS MANUAL

8.0 APPENDIX 8-3

9.0 THEORY OF OPERATION 9-3

9.1 Mechanical Operation 9-3
9.2 Electronic Operation 9-3

10.0 BILLS OF MATERIAL AND SCHEMATICS 10-1

TABLE OF CONTENTS

List of Figures

SECTION	FIGURE		PAGE
1.0	1.1	Front Panel Indicators and Collimator Operation	1-2
2.0	2.1	Component Identification	2-2
	2.2	Collimator to Focal Spot Distance	2-6
	2.3	Power Chassis Mounting Dimensions	2-6
	2.4	Cabling Outline	2-7
	2.5a, b, c	Terminal Strip Connections	2-7 & 2-8
	2.6	Exposure Interlock Connections (Exposure Hold Circuit)	2-9
	2.7	Tomo/Stereo Bypass Connections	2-9
	2.8	Cassette Tray Circuit	2-9
	2.9a, b	Horizontal SID Connections (Non-Tilt and Tilt Tables)	2-10
	2.10	Table Tilt Monitor Orientation	2-10
	2.11	Table Tilt Monitor Connections	2-10
3.0	3.0	Top and Bottom Cover Removal	3-2
	3.1	Logic P.C.B. LED Locations	3-10
	3.2	Logic P.C.B. Switch Locations	3-10
4.0	4.1	Light Field vs. X-Ray Field Congruency	4-3
	4.2	Cassette Tray Potentiometer Wiring	4-5
5.0	5.1	Light Field and Bucky Light Line Adjustment	5-2
6.0	6.1	BRH/FDA Compliance Test Stand	6-2
	6.2	Compliance Stand Detail	6-2
	6.3	Light Field vs. X-Ray Field Error Measurements	6-4
	6.4	Determination of SID	6-6
	6.5	Metal Marker Method	6-6
	6.6	Beam Quality Graphing Examples	6-20
9.0	9.1	Collimator Head Mechanical View	9-2
	9.2	Block Diagram	9-3
	9.3	Tilt Switch Functions	9-5
10.0	10.1	Feedback Pot & Motor Wiring	10-3
	10.2	Logic Board Schematic (70-08080)	10-7
	10.3	Logic Board Assembly (70-08080)	10-8
	10.4	Master Board Schematic (70-08081)	10-11
	10.5	Master Board Assembly (70-08081)	10-12
	10.6	Lamp & Driver Board Schematic (70-08082)	10-15
	10.7	Lamp & Driver Board Assembly (70-08082)	10-16

TABLE OF CONTENTS

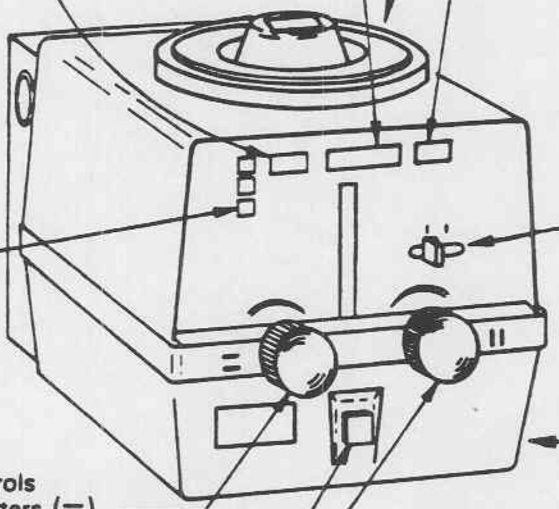
List of Tables

SECTION	TABLE		PAGE
2.0	2-1	Cassette Sizes vs. Output Voltage	2-5
3.0	3-1	Linear II Logic Chart	3-9
6.0	6-1	Minimum Beam Quality Requirements	6-17
	6-2	Aluminum Equivalent of Primary Beam Total Filtration	6-17
	6-3	Highest Design Operating Range	6-19
	6-4	Half-Value Layers as a Function of Filtration and Tube Potential for Diagnostic Units	6-19
8.0	8-1	Tube Mounting Information	8-2
	8-2	Signal Names Definitions	8-3
	8-3	40 Conductor Cable Color Cross Reference	8-4
	8-4	Linear II Logic Chart	8-5
	8-5	Tilting Wall Bucky Interface	8-6
10.0	10-1	Bills of Material - Logic PCB Assembly (70-08080)	10-5
	10-2	Bills of Material - Master PCB Assembly (70-08081)	10-9
	10-3	Bills of Material - Lamp & Driver PCB Assembly (70-08082)	10-13

SECTION 1.0

INTRODUCTION

FRONT PANEL INDICATORS & COLLIMATOR OPERATION



READY INDICATORS:
Dual lamps indicate when each shutter is properly positioned.

TEST SWITCH – Pushbutton located on rear panel. Pressing test switch applies a voltage to drive motors and **ALL** indicator lamps for "TEST".

MANUAL INDICATOR:
Indicates when:
- Collimator is tilted greater than ± 10°
- Table is tilted 10° from vertical or horizontal
- Cassette is not located in cassette tray
- Cassette tray is not fully inserted
- External stereo/tomo command is supplied.

EXPOSURE HOLD INDICATOR:
Indicates when:
- Shutters are not properly positioned
- When vertical SID is not positioned at 40" SID
- When horizontal SID is not positioned at standard SID's.

40" & 72"
HORIZONTAL SID INDICATORS:
Indicator lamps correspond to horizontal SID's.

HORIZONTAL SID SCALE
Position Knob:
Sliding knob positions the scale at 40" or 72" with detents. Indication representing field coverage at these SID's.

MIRROR RETRACTOR
Located next to cone track for x-ray tube inspection.

This dial controls the cross shutters (=)

Pushbutton to start timed light field display.

This dial controls the long shutters. (II)

PBL OPERATION

- Insert cassette into cassette tray
- Press "lamp" pushbutton to activate light field and bucky centering light line. Properly center bucky/cassette
- Indicators will go from MANUAL to EXP. HOLD while collimator shutters are moving, and then to READY when shutters are properly aligned.
- At this point you may reduce the x-ray field size if desired.

MANUAL OPERATION

- Press the "lamp" pushbutton to activate the light field. Adjust the shutters (both long and cross) to a size not larger than the film to be used.
- Center light field over cassette or anatomical area to be exposed.

FRONT PANEL INDICATORS AND COLLIMATOR OPERATION
Figure 1.1

1.0 INTRODUCTION

This manual contains information for the assembly, installation, adjustment, testing and maintenance of the LINEAR™ series of radiographic collimators manufactured by EUREKA X-RAY TUBE COMPANY.

1.1 YOU HAVE LEGAL OBLIGATIONS

The manufacturers of beam limiting devices are required to provide instructions for assembly, installation, adjustment and testing adequate to assure compliance with applicable provisions of DHHS Performance Standards 21 CFR Sub-Chapter J, Part 1020.

Those who assemble or service beam limiting devices must follow the instructions of the original manufacturer and process the FD-2579 Assemblers Report where applicable.

The responsibility for compliance of this product is assumed by failing to follow the original manufacturer's instructions or by modifying any component which affects radiation safety.

The FDA (BRH) requires that manufacturers must include a specific requirement that the assembler perform all applicable tests at the time of installation. A thorough explanation of the equipment required and step by step instructions must be provided by the manufacturer. The instructions include a requirement to record key data to demonstrate at a later time that all tests were performed and that the equipment was left in full compliance with the standards.

As an assembler, you must perform these tests for the applicable requirements at the time of installation and following any repairs which could alter the performance.

A Compliance Data Log is provided in this manual to record the results of the tests.

1.2 BACKGROUND

An x-ray collimator functions as an apparatus for regulating the cross-sectional size and shape of a beam of radiation which emerges from an x-ray tube.

The source of radiation is virtually a point-source and, due to the tube housing design, emerges from the port as a solid diverging cone of radiation. The finite angle of the anode surface limits the x-ray beam on the anode side (heel-effect) forming a "D" shaped x-ray field, limiting the useful coverage.

In "collimating" a beam to a given size and shape, a geared-pair of lead (Pb) plates (shutters) are moved symetrically into the beam to absorb the unwanted portion of the emerging beam. A second geared-pair of shutters are positioned at right angles to the first pair, and again are moved symetrically into the beam. In this manner a continuously variable square/rectangular beam is formed.

The landing area of the beam will contain a radiographic image receptor located in a plane perpendicular to the beam at pre-determined distances from the radiation source (focal spot).

The size and shape of the image receptor will determine the maximum useful cross-sectional size and shape of the beam in the plane of the image receptor. The source to image receptor distance (SID) determines the actual shutter opening required to regulate the beam size and shape in the plane of the image receptor.

"Positive" beam-limiting (PBL) devices incorporate means to prevent x-ray production until the beam limitation meets the applicable provisions of the Performance Standards.

Automatic PBL devices incorporate motors that regulate the shutter opening as required while manual PBL devices require the operator to adjust the shutters by the use of knobs, levers, etc.

The primary objective of the electronic logic circuitry is to limit the beam to the size of the image receptor and to provide other standardized operations consistent with the DHHS Performance Standards 21 CFR Sub-Chapter J. This is accomplished by electrically measuring the size of the image receptor and the distance (SID) involved. The resultant signal is then compared to a signal which represents the collimator shutter opening to form a means of limiting the beam.

The second objective is to provide convenience featues such as status indicator lights to aid and guide the operator in the use of the collimator, particularly with a manual PBL device.

1.3 LINEAR™ SERIES COLLIMATOR FEATURES

1.3.1 SERVICEABILITY:

The Linear™ series collimator logic provides a third objective not included with other similar products — serviceability. This new dimension is incorporated in a manner which allows a single positioning of the collimator above a table top for the diagnostic trouble-shooting of the logic and collimator functions. All calibrations are then done by observing the light-field projected onto a test pattern provided with each collimator.

The test pattern, in conjunction with the indicators and miniature programming switches located on the logic circuit board, virtually eliminates the requirement for a digital voltmeter for calibrating the collimator. Instrumentation as a rule will only be required to pinpoint a fault identified by the indicators and programming switches and for external circuitry. Also, locating the logic board on the collimator allows troubleshooting and adjustment from a central location while observing the results. As always, confirming radiation exposures are made only with all parties located in a radiation-protected area.

After confirming that the logic board and collimator are functional and calibrated, external signals can be selectively applied to check for correct operation. After all external signal sources are confirmed, the programming switches are then set to the "OFF" position with the collimating system returned to the normal operating condition.

1.3.2 MIRROR RETRACTION FEATURE:

When the need arises to visually inspect the port of the x-ray tube, the mirror may be retracted from the exposure position. Release of the mirror actuator restores the original position of the mirror.

1.4 STANDARD FEATURES (Model Linear II)

The Linear II™ automatic PBL collimation systems from EUREKA include all features required for diagnostic excellence . . .

. . . Rated for operation to 150 kVp.

. . . Full manual operation for table-top radiography.

. . . Automatic PBL operation upon insertion of a cassette into the bucky tray.

. . . Manual field size reduction after automatic PBL cycle.

. . . Color coded lights to indicate modes of operation.

. . . Bright 150 Watt light-field illumination operated by an internal timer.

. . . Square or rectangular pattern continuously variable from 17" x 17" at 36" SID to fully closed.

. . . Continuous size sensing capability for all metric and inch size cassettes.

. . . Compatible with Liebel-Flarsheim or Eureka MCT II cassette size sensing bucky and tray.

. . . Cone track provided for accessories.

. . . Swivel mount for angulated positioning.

1.5 ADVANCED FEATURES

The Linear™ collimation systems also incorporate features required for diagnostic convenience . . .

. . . Illuminated SID front panel indicators.

. . . Selectable field size scales to avoid confusion.

. . . Bright centering light-line which extends from the front of the extended cassette tray across the table-top to beyond the center of the patient, completely eliminates the need for mechanical "pointers".

1.6 TECHNICALLY ADVANCED FEATURES

The Linear™ collimation systems incorporate features for diagnostic down-time reduction . . .

. . . Push button for indicator lamp test function.

. . . Digital logic circuitry located on the side of the collimator for table-side troubleshooting convenience without x-ray exposures.

. . . Programming switches and indicators on the logic board permits simulation of cassette size signals and all SID functions. A built-in "logic probe" allows troubleshooting from a central location at table-side. After confirming that the logic board and collimator are fully functional, external signals can be selectively applied to check for correct external signals.

. . . Most electronic components are standardized types available at major electronic suppliers. Use of standardized staight-forward logic allows troubleshooting and repair with general electronic experience.

. . . An indicator lamp in the "light" switch will indicate when the field projector bulb requires replacement. A spare lamp is provided inside the lamp housing and is easily replaced by the owner/operator.

1.7 SPECIFICATIONS (Model Linear II)

Operation:	Automatic (PBL) within 2 seconds, and manual.
SID's for PBL:	Vertical SID at 40", 40" and 72" horizontal.
SID Indicators:	Horizontal SID indicators at 40" and 72".
Radiation Shielding:	Rated for 150 kVp. Less than 50 mR/Hr/mA at one meter.
Film Coverage:	Continuously variable from 17" x 17" to 5" x 5" in PBL mode at all listed distances, 17" x 17" to closed in Manual mode.
Light Field:	More than 160 LUX (15 footcandles) with a minimum edge contrast ratio of 4:1 at one meter. Controlled by internal timer.
Accuracy:	2% of SID in use.
X-ray Field Accuracy:	Within 2% of SID in use in length and width. (Sum less than 4%).
Bucky Light Line:	Bright center line extending from center of field to withdrawn tray.
PBL By-Pass:	Accepts by-pass signal from control for stereographic and tomographic operation.
Mirror/Filter Retraction:	Mirror retraction for port viewing.
Inherent Filtration:	2.0mm (min.) aluminum equivalent at 100 kVp and above.
Power Requirement:	115-125 VAC, 50/60 Hz, 2 Amp, 3 Wire, 1 Phase.
Light-Field Lamp:	Type DZE, 24 VAC, 150 WATT (GE).
Weight:	19 lbs. (collimator head only).

(Note: Specifications subject to change without notice.)

1.8 RADIATION AND MECHANICAL/ELECTRICAL WARNING
(from NEMA Standards Publication/No. XR8-1979)

Radiation ☢ Warning for Diagnostic X-Ray Systems

X-rays are dangerous to both operator and others in the vicinity unless established safe exposure procedures are strictly observed.

The useful and scattered beams can produce serious, genetic or potentially fatal bodily injuries to any persons in the surrounding area if used by an unskilled operator. Adequate precautions must always be taken to avoid exposure to the useful beam, as well as to leakage radiation from within the source housing or to scattered radiation resulting from the passage of radiation through matter.

Those authorized to operate, test, participate in or supervise the operation of the equipment must be thoroughly familiar and comply completely with the currently established safe exposure factors and procedures described in publications such as Sub-Chapter J of Title 21 of the Code of Federal Regulations, *"Diagnostic X-ray Systems and their Major Components"*, and the National Council on Radiation Protection (NCRP) No. 33, *"Medical X-Ray and Gamma-Ray protection for energies up to 10 MeV-Equipment Design and Use"*, as revised or replaced in the future.

Failure to observe these warnings may cause serious, genetic or potentially fatal bodily injuries to the operator or those in the area.

Mechanical-Electrical ⚡ Warning for Diagnostic X-ray Systems

All of the movable assemblies and parts of x-ray equipment should be operated with care.

Only properly trained and qualified personnel should be permitted access to any internal parts. Live electrical teminals are deadly; be sure line disconnect switches are opened and other appropriate precautions are taken before opening access doors, removing enclosure panels, or attaching accessories.

Do not remove the flexible high tension cables from the x-ray tube housing or high tension generator or the access covers from the generator until the main and auxiliary power supplies have been disconnected.

When disconnecting high-voltage cables, they must be grounded immediately in order to dissipate any electrical charge that may remain on the cables or the tube.

Failure to comply with the foregoing may result in serious or potentially fatal bodily injuries to the operator or those in the area.

1.9 COMPATIBILITY

The Linear™ series collimators are compatible and can be adapted for use with x-ray tube/housing assemblies that meet all of the following factors:

1. Focal Distance of X-ray Tube:

   The focal spot to collimator mounting flange distance must be 2.44 inches, ±0.031 inches (1/32"). Four (4) spacers are supplied for adaption:

   1 – 1/4 inch (0.25") spacer
   3 – 1/16 inch (0.06") spacer

   Use any combination to achieve the requirements.Refer to Section 8.0, Appendix, Table 1 for additional information.

2. Leakage Radiation:

   Maximum leakage radiation from the x-ray tube/housing assembly must not exceed 50 mR/hr at 100 cm (40 inches) at specified leakage technic factors.

3. Inherent Filtration and Half-Value Layer:

   The EUREKA Linear™ series collimators have a minimum value of 2.0mm aluminum equivalence at 100 kVp. This value plus any tube inherent filtration plus any added filtration must meet the minimum requirements of 21 CFR Sub-Chapter J, part 1020.30 (m)(1) Table 1 on beam quality (e.g., minimum HVL at 100 kVp must be 2.7mm Al).

4. Application:

   The intended application is for general purpose radiographic equipment including tomographic and chest applications. Maximum tube rating must be 150 kVp or less.

5. Installation:

   Must be made with supplied hardware including mounting flange, spacers (as required), and four (4), 1/4" x 20 bolts equally spaced on a 3.62" diameter bolt center.

1.10 MAINTENANCE

The collimator system must be properly maintained to assure both compliance with the BRH regulations and useful life.

Preventive maintenance is to be performed once every twelve months. This includes inspection and lubrication of both the cassette tray(s) and collimator mechanism.

Checkout should also occur if any of the following conditions occur:

Lamp replacement
Premature electronic component failure
When collimator is removed from tube/housing assembly
When collimator and/or cassette tray have been subjected to external damage.

Refer to Section 3.0 for collimator CHECK-OUT procedure, and refer to the cassette tray manual for tray maintenance.

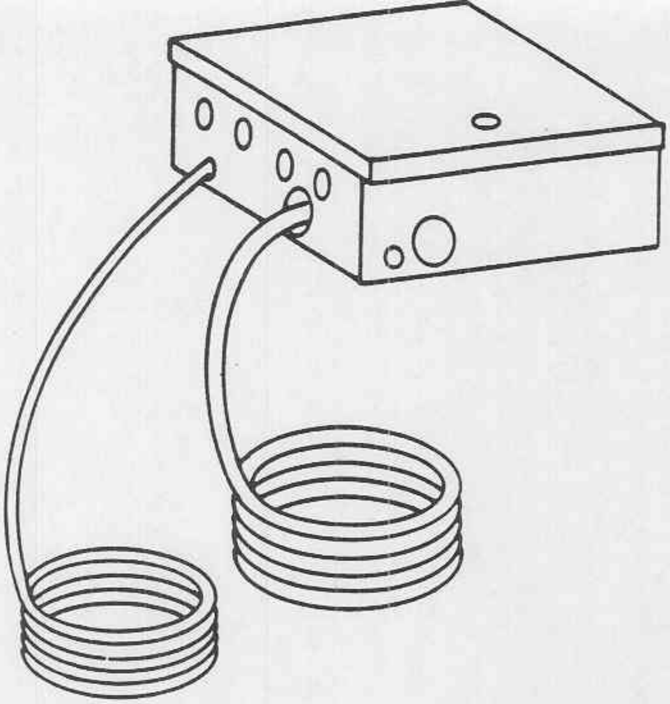
1.11 COMPLIANCE REQUIREMENTS

It is necessary for the assembler to verify compliance. A series of tests, when performed at the time of installation, will indicate compliance with 21CFR, Sub-Chapter J, Part 1020. Performance Standards. These tests which are described in Section 6, "Compliance Verification", must be performed before releasing the collimator for use. A record sheet is provided at the end of Section 6 and should be completed by the installer. In order to avoid wasted effort the installation, checkout and adjustment procedures descibed in Sections 2 through 5 should be completed prior to performing the compliance tests

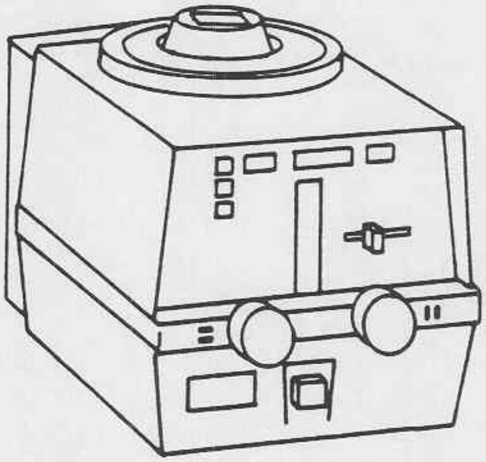
NO TEXT

SECTION 2.0

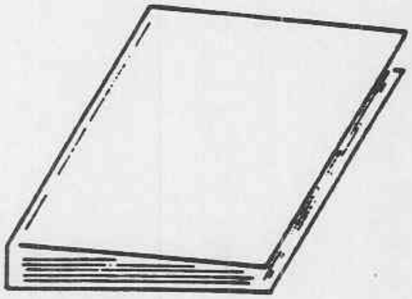
INSTALLATION



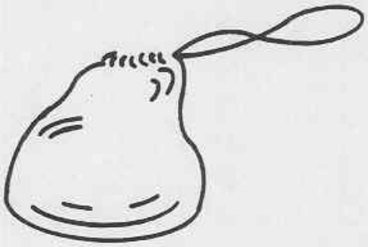
INTERCONNECT AND POWER SUPPLY UNIT



COLLIMATOR



MANUAL



MOUNTING HARDWARE AND SPACERS

COMPONENT IDENTIFICATION
FIGURE 2.1

2.0 INSTALLATION

2.1 Unpacking

Carefully unpack the equipment and check for damage incurred during shipment. Any damage should be referred to the agency that delivered the product.

2.2 Equipment Supplied

Refer to figure 2.1 for component identification.

- Linear II Collimator
- Spacers and Mounting Hardware
- Interconnect and Power Supply Unit
- Packet containing Instruction Manual, Assembler's Report FD-f2579, etc.

2.3 Collimator Mounting

Determine the collimator mounting surface to focal spot distance from the data supplied with the x-ray tube (do not rely on an inscribed mark on the tube housing).

NOTE: The collimator will not perform properly unless the focal spot to upper swivel ring distance is $2\frac{7}{16}$" *(2.44 inches, 62 mm.)* ± $\frac{1}{32}$" *(.031 inches, 1 mm.). Be sure to include any permanent mounting plates in the focal spot to port boss distance stated in the tube manufacturer's data.*

***NOTE:* The Linear II is designed to be used *with* a lead diaphragm or cone in the plastic port of the x-ray tube.**

If it is found that lead diaphragms or cones require removal or modification, consult the factory.

Determine the total thickness of the supplied spacers(s) that must be added between the upper swivel ring of the collimator mounting surface, to obtain a focal spot to upper swivel ring distance of $2\frac{7}{16}$" (2.44 inches, 62 mm.) ± $\frac{1}{32}$" (.031 inches, 1 mm.). Refer to Figure 2.2.

Remove the upper swivel ring from the collimator by removing the 6-32 socket head cap screw and opening the clamping ring.

Securely fasten the upper mounting ring and spacers to the collimator mounting surface.

Carefully support the collimator in place and re-attach the clamping ring. The hinge of the clamping ring must line up with the pin in the lower mounting ring.

2.4 Power Chassis Mounting

The power chassis is a standard NEMA enclosure intended to be mounted on a wall or in an equipment cabinet. There are knock-outs on the sides and bottom of the enclosure for cable entry. Locate the power chassis in an area that will permit:

1. Cable Bend Radius
2. Convection Cooling
3. Clearance for Door Opening

All external connections to the system are made in this chassis. They include:

1. AC Power Input
2. Table Image Receptor Input
3. Wall Image Receptor Input
4. Horizontal SID Input
5. 40" Vertical SID Input
6. Table Tilt Monitor
7. Generator Exposure Interlock
8. Tomo/Stereo By-Pass Input

Refer to the Power Chassis outline drawing for mounting dimensions. (Figure 2.3)

2.5 Interconnect Wiring

(Refer to Cabling Outline Figure 2.4)

CAUTION: You will be wiring 120 VAC into the power chassis. Be sure that the x-ray generator is off before proceeding.

All connections are located inside the power chassis (Refer to terminal strip layout – Figure 2.5-a, b, c and Schematic 70-08009).

2.5.1 120 VAC Input

Connect the three-wire cable supplied to the 120 VAC source as follows:

Black – Hot
White – Neutral
Green – Ground

2.5.2 Exposure Interlock

Connect the supplied cable to the exposure interlock circuit of the generator (refer to the generator manual). The collimator "Exposure Hold" is a set of normally open contacts that remain open in the "Hold" condition (Refer to Figure 2.6). The contacts are Form C with the normally closed contacts available.

2.5.3 Tomo/Stereo Input

If the x-ray system is equipped with either Tomo or Stereo shift capability it will be necessary to connect a signal to the collimator Tomo/Stereo by-pass input. This circuit accommodates a variety of signals. Determine the signal level available from the Generator Installation Manual. Connect as indicated in Figure 2.7.

2.5.4 Table Image Receptor Input

The Linear collimator systems are designed to operate with input characteristics as listed below.

Refer to the Cassette Tray Installation Manual and the appropriate Bucky Manual to assure proper operation of these devices.

Connect the table image receptor input as indicated in Figure 2.8.

ELECTRICAL SPECIFICATIONS:

- Impedance – 1000 OHMS, ±5% total resistance
- Resistance Linearity – within 1.5%
- Output Voltage vs. Cassette Size with +15.00 volts applied between SUPPLY and COMMON Terminals is shown in the center column on the following page.
- Operating Output Voltage vs. Cassette Size with +7.02 volts applied at 40" SID is shown in the right-hand column in the table on the following page.

Table 2-1 Cassette Sizes vs. Output Voltage

Cassette/Film Size		DC Output Voltage ±0.2 V (15.00 volts input)		DC Output Voltage 40" SID (7.02 volts input)	
INCH	CM (metric)				
5		0.90		2.30	
6		1.95		2.65	
7		3.15		3.05	
	18		3.25		3.08
8		4.20		3.40	
9		5.25		3.75	
	24		5.79		3.93
10		6.45		4.16	
11		7.50	<–Reference Point	4.51	
	30		8.27		4.77
12		8.70		4.91	
	35		10.57		5.54
14		10.80		5.61	
	43		14.03		6.69
17		14.10		6.72	

2.5.5 Auxiliary Wall Cassette Tray Installation

When an auxiliary wall cassette or size-sensing wall cassette holder is installed in the system, connect the inputs to the power chassis as indicated in Figure 2.8.

Identify the location of the auxiliary cassette tray or holder with respect to the collimator. Remove the bottom collimator cover as shown in Figure 3.0. Set the appropriate switch located on the collimator Logic P.C.B.:

A. Wall Cassette Right – Set SW2-5 "ON"
B. Wall Cassette Left – Set SW3-5 "ON"
(Refer to Figure 3.2)

NOTE: Only one of these switches is to be placed in the "ON" position at any time.

2.5.6 Discrete Vertical SID Installation (40" Only)

If the system is to be mounted on a variable SID tubestand, it is necessary to install a switch to be activated at the 40" vertical SID position as shown in Figure 2.5(a).

The switch must be installed to activate within ±0.2 inches of the 40 inch SID position.

Connect the Normally Open contacts to TS1-17 and TS1-19.

If the collimator is mounted at a permanent vertical SID position, connect a jumper wire between TS1-17 and TS1-19.

2.5.7 Horizontal SID Installation

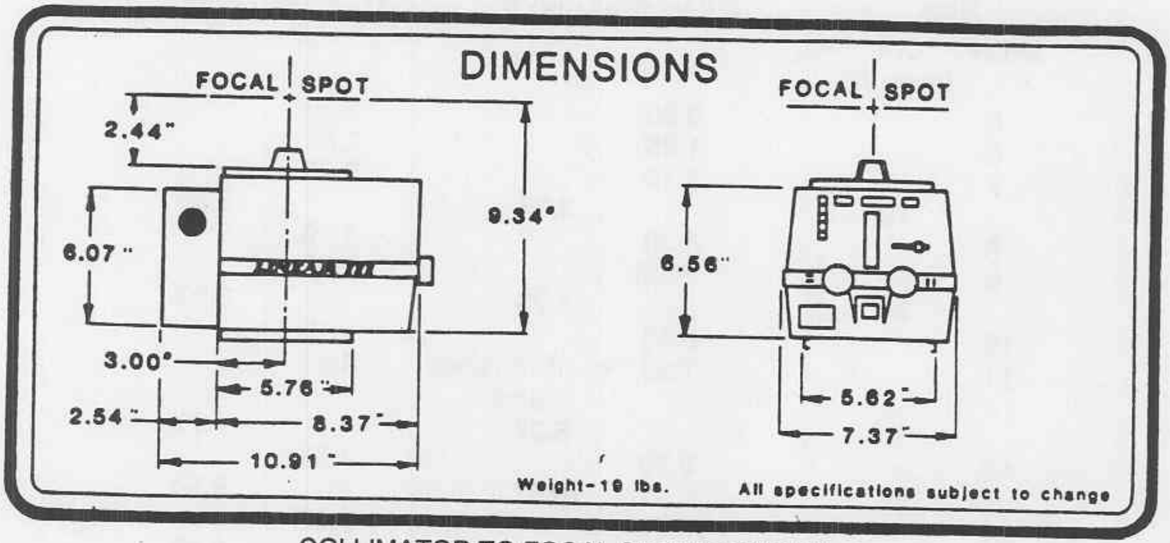
A switched signal is required at the horizontal SID positions to be used. Only one switched signal is to be present at any one time. Position each of the switches to close within ±0.2 inches of their respective SIDs.

Connect the switches to the Power Chassis as indicated in Figure 2.9(a) for Non-Tilt Tables and 2.9(b) for Tilting Tables.

2.5.8 Table Tilt Monitor

If a tilting table is installed as part of the system, it is necessary to mount the table tilt monitor to transfer angular position information to the collimator. Proper orientation of the monitor is shown in Figure 2.10.

Remove the jumper between TS2-5 and TS2-10. Connect the table tilt monitor as in Figure 2.11.


DIMENSIONS
FOCAL SPOT
2.44"
6.07"
9.34"
3.00"
5.76"
2.54"
8.37"
10.91"
FOCAL SPOT
6.56"
5.62"
7.37"
Weight-19 lbs.
All specifications subject to change

COLLIMATOR TO FOCAL SPOT DISTANCE

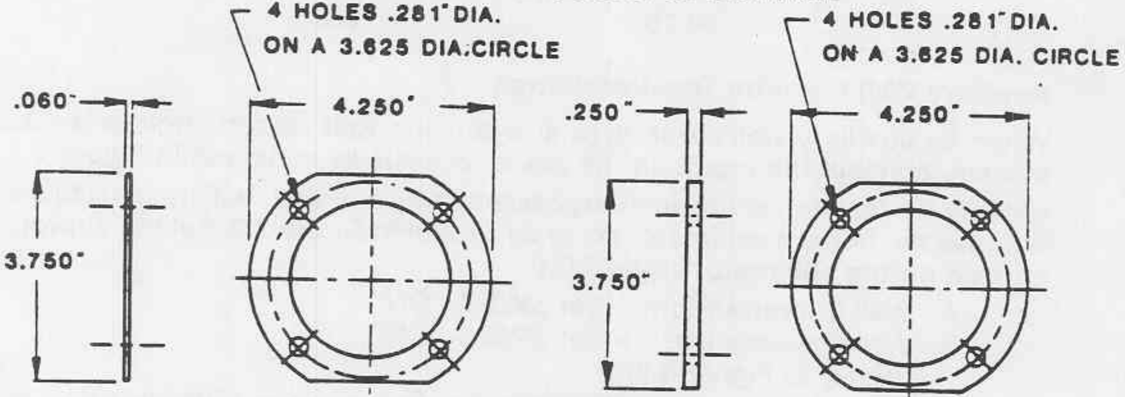
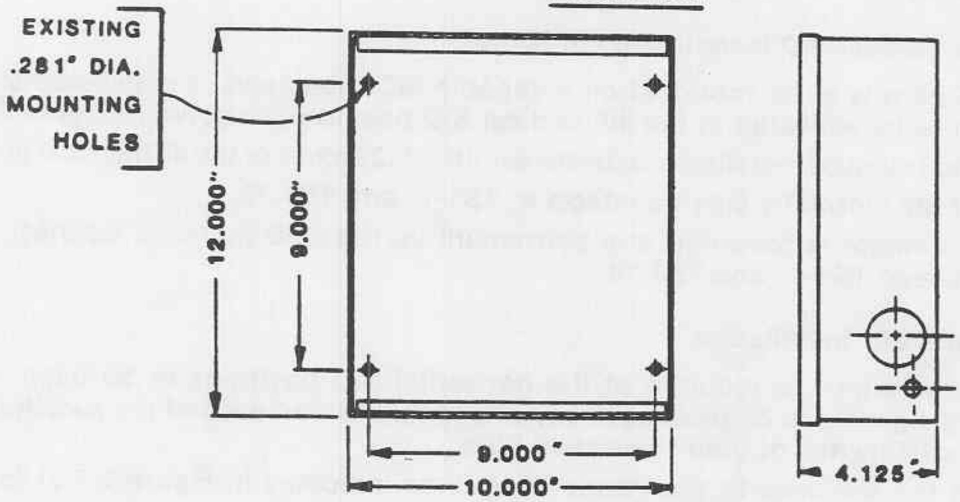
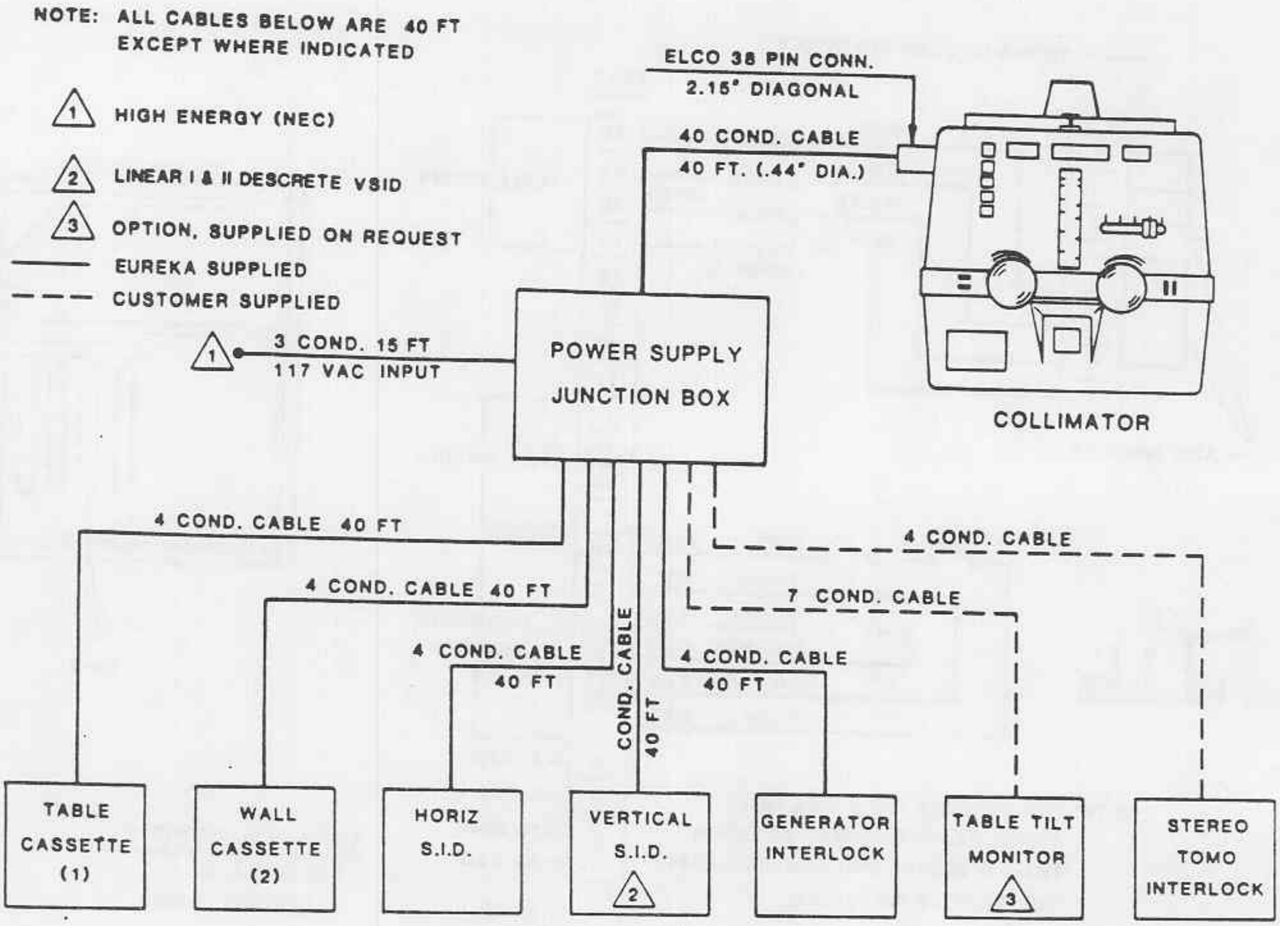

4 HOLES .281" DIA.
ON A 3.625 DIA.CIRCLE
.060"
4.250"
3.750"
4 HOLES .281" DIA.
ON A 3.625 DIA. CIRCLE
.250"
4.250"
3.750"

FIGURE 2.2


EXISTING
.281" DIA.
MOUNTING
HOLES
12.000"
9.000"
9.000"
10.000"
4.125"

POWER CHASSIS MOUNTING DIMENSIONS

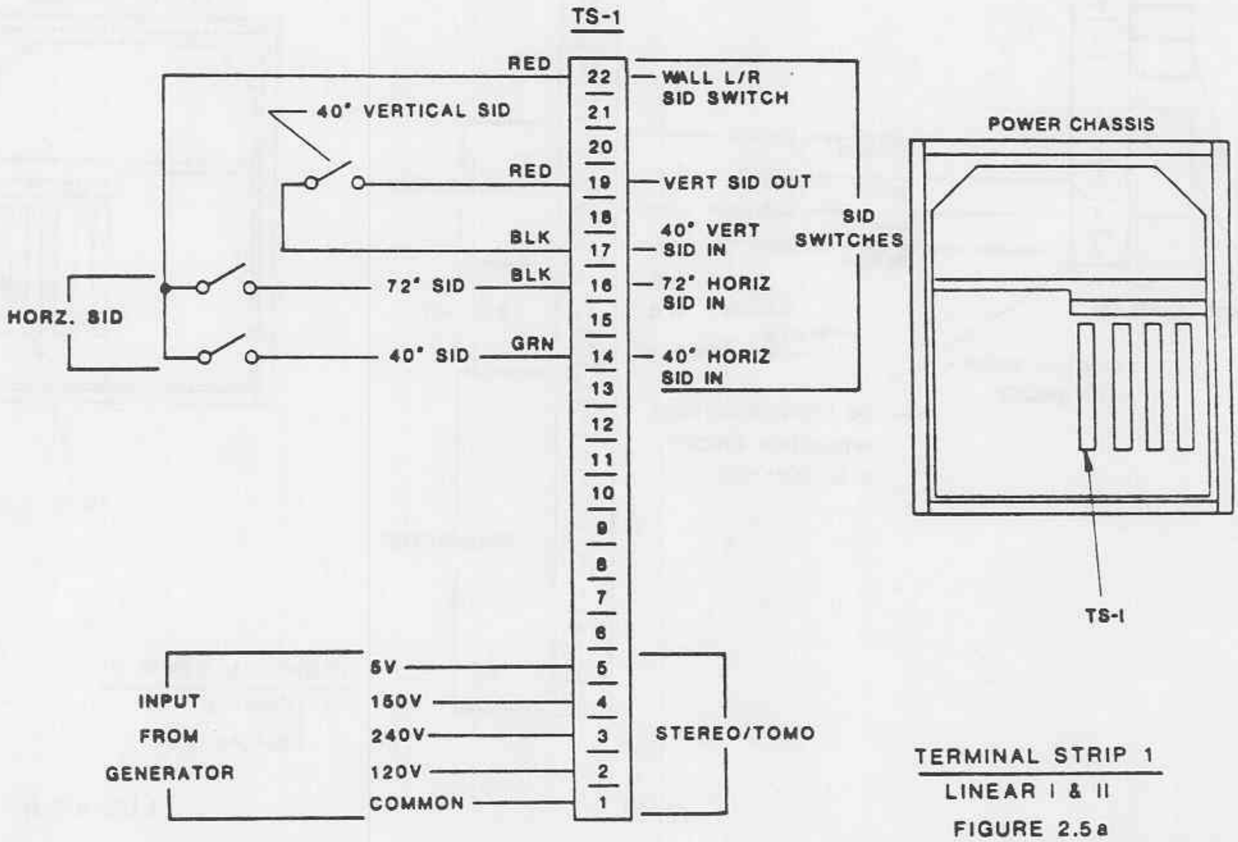
FIGURE 2.3


NOTE: ALL CABLES BELOW ARE 40 FT EXCEPT WHERE INDICATED
1 HIGH ENERGY (NEC)
2 LINEAR I & II DESCRETE VSID
3 OPTION, SUPPLIED ON REQUEST
EUREKA SUPPLIED
CUSTOMER SUPPLIED
ELCO 38 PIN CONN. 2.15" DIAGONAL
40 COND. CABLE 40 FT. (.44" DIA.)
COLLIMATOR
1
3 COND. 15 FT 117 VAC INPUT
POWER SUPPLY JUNCTION BOX
4 COND. CABLE 40 FT
4 COND. CABLE 40 FT
4 COND. CABLE 40 FT
4 COND. CABLE 40 FT
4 COND. CABLE 40 FT
7 COND. CABLE
4 COND. CABLE
TABLE CASSETTE (1)
WALL CASSETTE (2)
HORIZ S.I.D.
VERTICAL S.I.D. 2
GENERATOR INTERLOCK
TABLE TILT MONITOR 3
STEREO TOMO INTERLOCK

CABLE CONFIGURATION FOR #70-40000 LINEAR II

CABLING OUTLINE

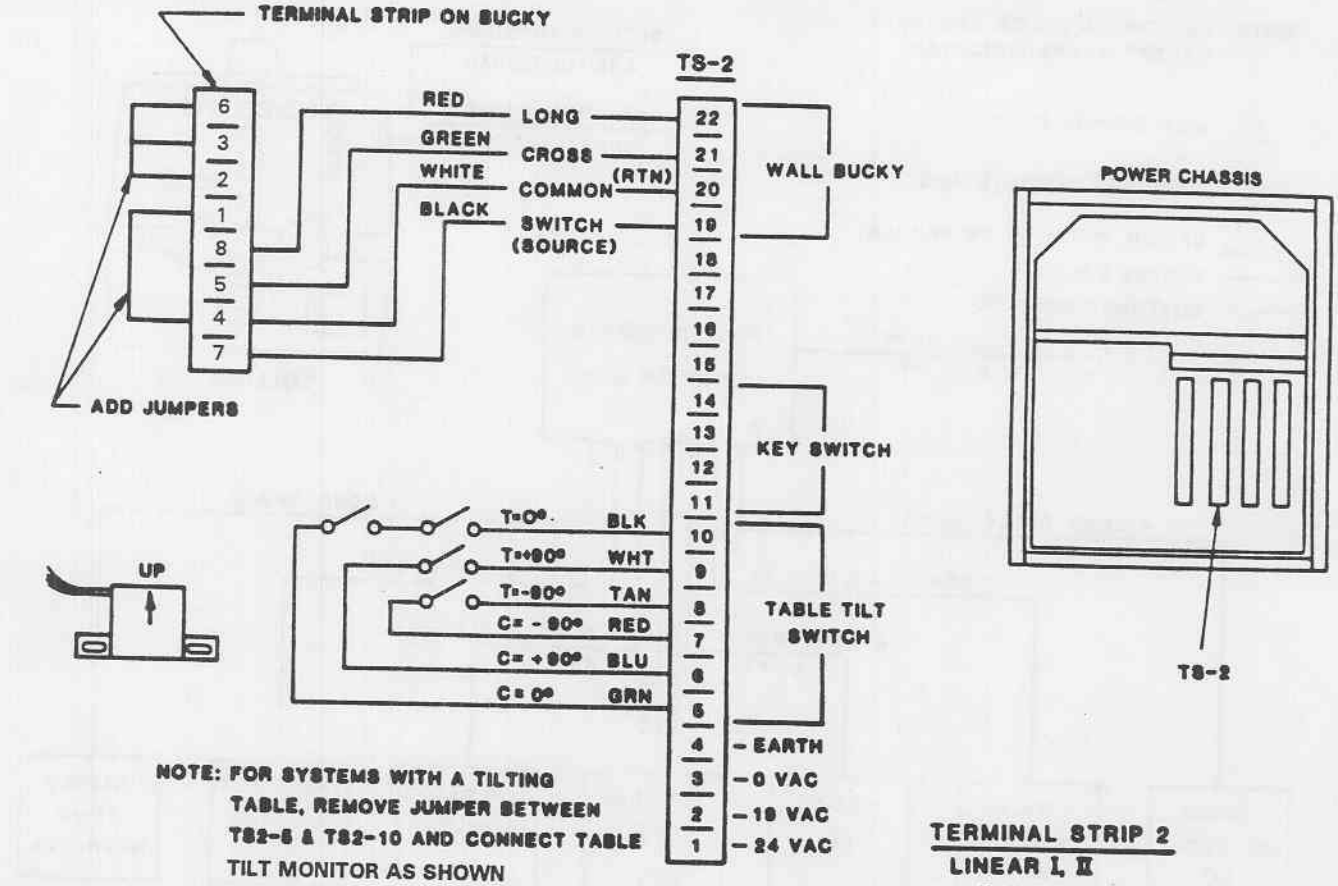
FIGURE 2.4


TS-1
RED
22
WALL L/R SID SWITCH
21
40" VERTICAL SID
20
RED
19
VERT SID OUT
18
40" VERT SID IN
BLK
17
SID SWITCHES
HORZ. SID
BLK
72" SID
16
72" HORIZ SID IN
15
GRN
40" SID
14
40" HORIZ SID IN
13
12
11
10
9
8
7
6
INPUT FROM GENERATOR
5V
5
150V
4
240V
3
120V
2
COMMON
1
STEREO/TOMO
POWER CHASSIS
TS-I

TERMINAL STRIP 1

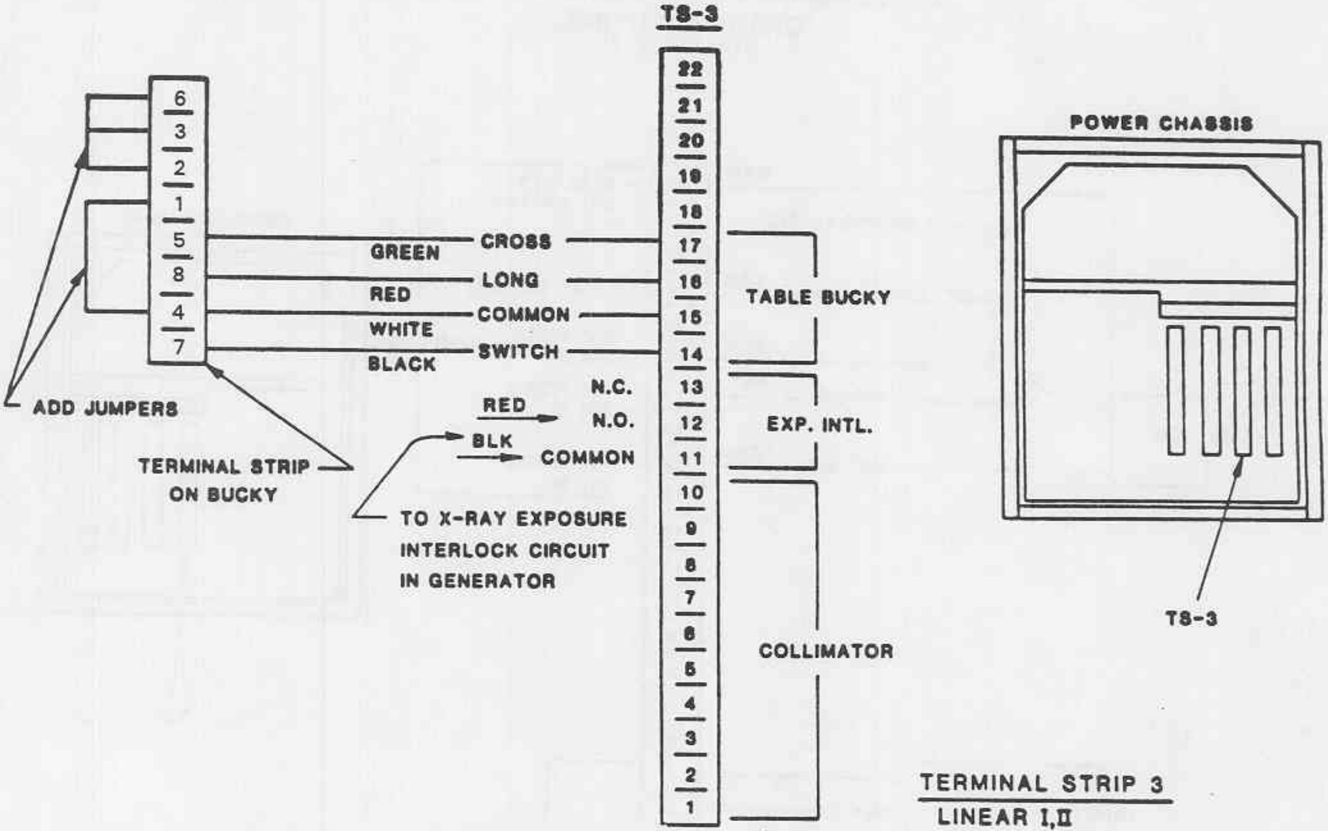
LINEAR I & II

FIGURE 2.5a


TERMINAL STRIP ON BUCKY
6
3
2
1
8
5
4
7
ADD JUMPERS
RED
GREEN
WHITE
BLACK
LONG
CROSS
COMMON
(RTN)
SWITCH
(SOURCE)
TS-2
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
WALL BUCKY
KEY SWITCH
TABLE TILT
SWITCH
UP
T=0°
T=+90°
T=-90°
C= -90°
C= +90°
C= 0°
BLK
WHT
TAN
RED
BLU
GRN
- EARTH
- 0 VAC
- 18 VAC
- 24 VAC
POWER CHASSIS
TS-2

NOTE: FOR SYSTEMS WITH A TILTING TABLE, REMOVE JUMPER BETWEEN TS2-5 & TS2-10 AND CONNECT TABLE TILT MONITOR AS SHOWN

TERMINAL STRIP 2
LINEAR I, II
FIGURE 2.5b


TS-3
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
6
3
2
1
5
8
4
7
ADD JUMPERS
TERMINAL STRIP
ON BUCKY
GREEN
CROSS
RED
LONG
WHITE
COMMON
BLACK
SWITCH
N.C.
RED
N.O.
BLK
COMMON
TO X-RAY EXPOSURE
INTERLOCK CIRCUIT
IN GENERATOR
TABLE BUCKY
EXP. INTL.
COLLIMATOR
POWER CHASSIS
TS-3

TERMINAL STRIP 3
LINEAR I,II
FIGURE 2.5c

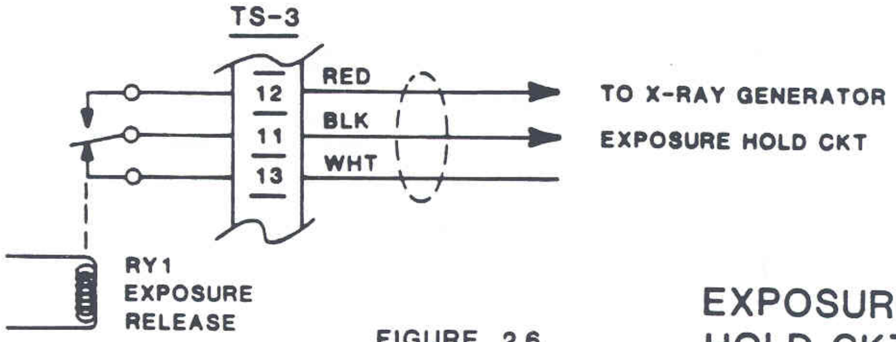

TS-3
RED
BLK
WHT
12
11
13
TO X-RAY GENERATOR
EXPOSURE HOLD CKT
RY1
EXPOSURE
RELEASE

FIGURE 2.6

EXPOSURE
HOLD CKT.

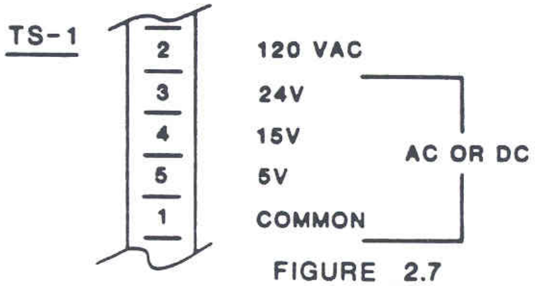

TS-1
2
3
4
5
1
120 VAC
24V
15V
5V
COMMON
AC OR DC

FIGURE 2.7

TOMO/STEREO
BY-PASS

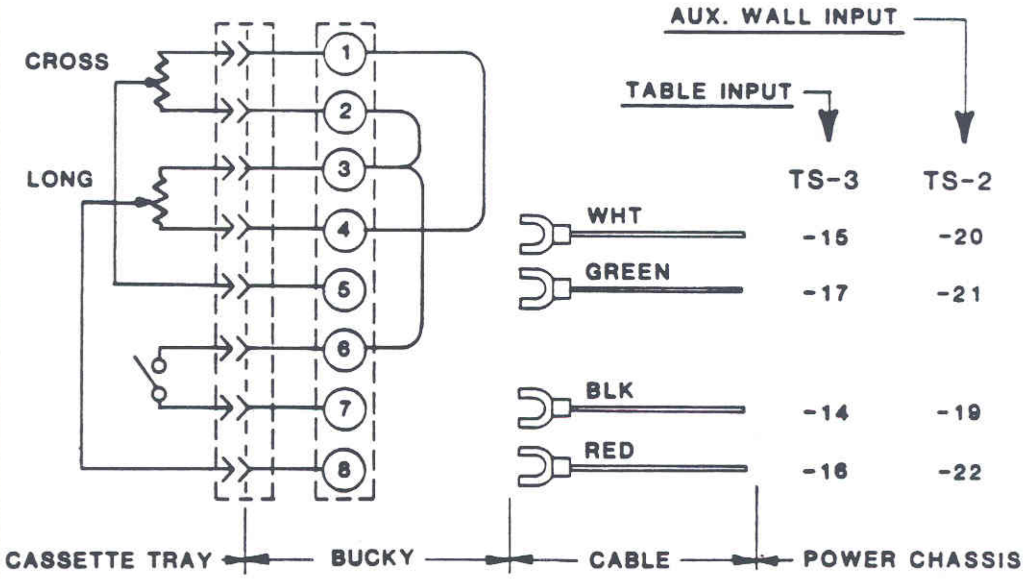
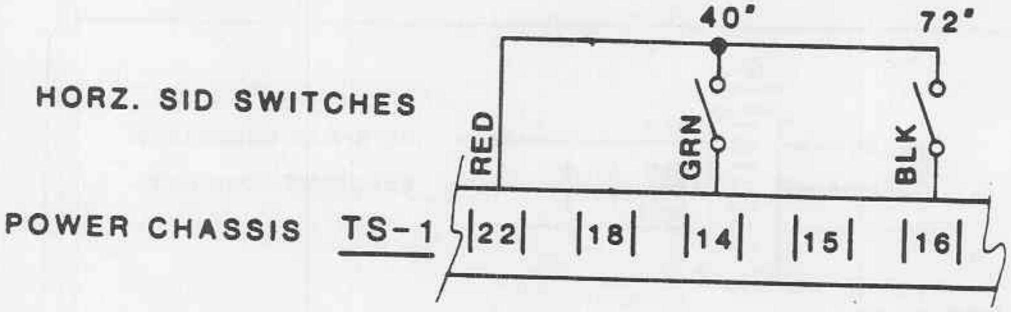

AUX. WALL INPUT
TABLE INPUT
CROSS
LONG
1
2
3
4
5
6
7
8
TS-3
TS-2
WHT
-15
-20
GREEN
-17
-21
BLK
-14
-19
RED
-16
-22
CASSETTE TRAY
BUCKY
CABLE
POWER CHASSIS

FIGURE 2.8

CASSETTE TRAY CKT.


HORZ. SID SWITCHES
40"
72"
RED
GRN
BLK
POWER CHASSIS
TS-1
22
18
14
15
16

FOR:
NON-TILT TABLE SYSTEMS

FIGURE 2.9a

HORIZONTAL
SID SWITCH CKT.

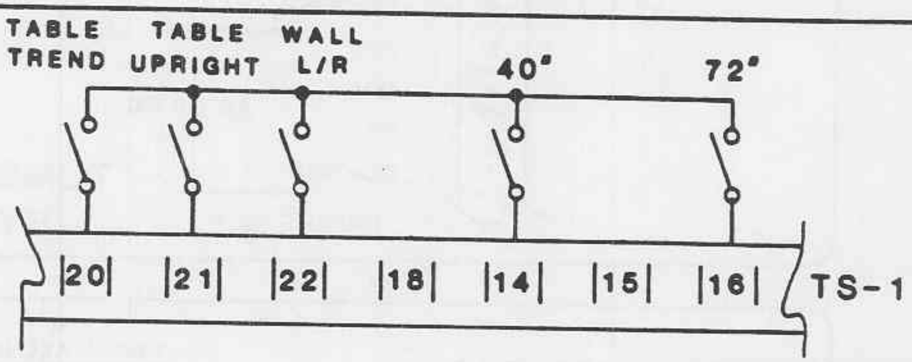


TABLE
TREND
TABLE
UPRIGHT
WALL
L/R
40"
72"
20
21
22
18
14
15
16
TS-1

FOR:
TILT TABLE SYSTEMS

FIGURE 2.9b

HORIZONTAL
SID SWITCH CKT.

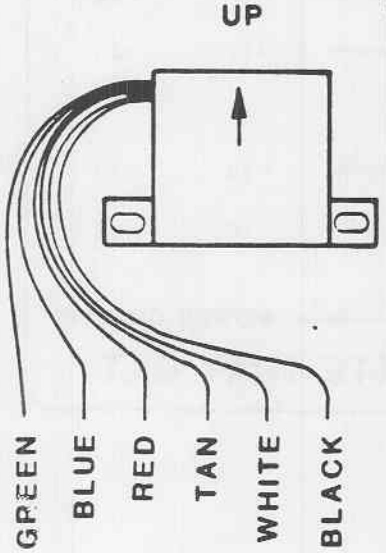

UP
GREEN
BLUE
RED
TAN
WHITE
BLACK

TABLE TILT MONITOR
ORIENTATION

FIGURE 2.10

NOTE: FOR NON-TILT TABLE SYSTEMS JUMPER
TS2-5 TO TS2-10

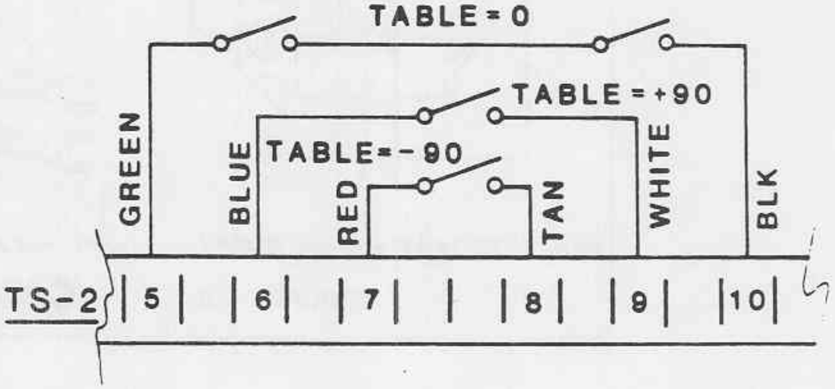


TABLE = 0
TABLE = +90
TABLE = -90
GREEN
BLUE
RED
TAN
WHITE
BLK
TS-2
5
6
7
8
9
10

TABLE TILT MONITOR CONNECTIONS

FIGURE 2.11

SECTION 3.0

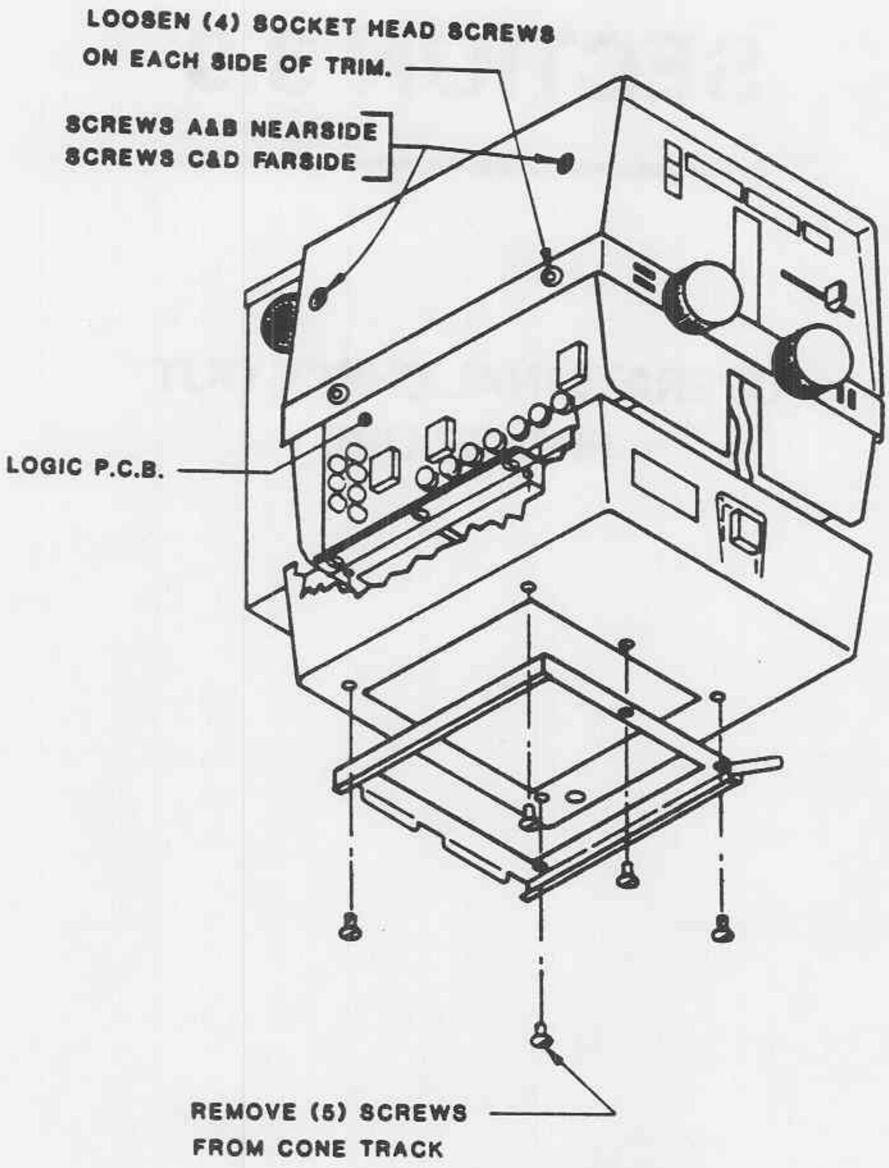
OPERATIONAL CHECK OUT PROCEDURE

TOP COVER REMOVAL

(TO GAIN ACCESS TO TOP HALF OF LOGIC P.C.B. AND LAMP DRIVER P.C.B. BEHIND FRONT PANEL)

1. LOOSEN, DO NOT REMOVE, THE 4 SCREWS ON THE TRIM BAND
2. REMOVE SCREWS A, B, C AND D
3. LIFT TOP COVER AND PULL FORWARD

COVER REMOVAL


LOOSEN (4) SOCKET HEAD SCREWS
ON EACH SIDE OF TRIM.
SCREWS A&B NEARSIDE
SCREWS C&D FARSIDE
LOGIC P.C.B.
REMOVE (5) SCREWS
FROM CONE TRACK

BOTTOM COVER REMOVAL

1. LOOSEN, DO NOT REMOVE, THE 4 SCREWS ON THE TRIM BAND, 2 EACH SIDE
2. REMOVE THE CONE TRACK
3. LAMP SWITCH MAY BE REMOVED FROM COVER AND RE-CONNECTED

FIGURE 3.0

3.0 OPERATIONAL CHECKOUT PROCEDURES – MODEL LINEAR II

The following procedures form a means to check operation of the collimating system and must be performed at the time of installation.

These procedures also form a key troubleshooting aid by using internal SID and IR signals to check for correct Logic PCB and collimator response, followed by use of external signals to check the wiring.

Although some signals are internally simulated, external wiring or component defects can prevent proper operation by producing false input signals. An external short circuit to ground for example, on the 40" SID switch will prevent the 40" indicator from coming ON. During any of the following tests, an incorrect indication or operation must be identified and corrected before continuing with the tests.

These procedures are written in a specific sequence; altering the sequence will result in misjudgement and a waste of time.

YOU HAVE LEGAL OBLIGATIONS

PRIOR TO RELEASE OF THE SYSTEM TO THE USER, THE RESULTS OF EACH STEP MUST BE AS DEFINED.

ENTER THE APPROPRIATE DATA IN THE SPACES PROVIDED IN THE COMPLIANCE DATA-LOG AND RETAIN FOR YOUR RECORDS AS PROOF THAT THESE TESTS WERE SUCCESSFULLY PERFORMED.

EQUIPMENT REQUIRED:

A. The x-ray tube support and the table must include angulation indicators in order to comply with Part 1020.31 (d)(2)(i) and 1020.31 (e)(1)(ii). These indicators are to be used for the following tests.

B. The x-ray tube support device also must include SID indicating means in order to comply with 1020.31 (e)(1)(i).

C. Measuring tape (ruler). This is to be used as a backup for the SID indicating means and as an operational range measurement.

3.1 REMOVE COLLIMATOR COVER AS SHOWN IN FIGURE 3.0

Set the switches on the logic PCB shown in Figure 3.2 as follows:

SW2-1	OFF	SW3-1	OFF
SW2-2	OFF	SW3-2	OFF
SW2-3	OFF	SW3-3	OFF
SW2-4	OFF	SW3-4	OFF
SW2-5	OFF	SW3-5	OFF

3.2 COLLIMATOR TILT SWITCH CHECKOUT

Position the tilt switch at 0°, horizontal. Angulate the collimator to a 0° beam-down position. Slowly angulate the collimator +20° toward a beam-left position and back to −20° toward a beam-right position.

LED-4, Figure 3.1, must be on at 0° and remain on for +11° and −11° angulations.

3.2.1 Angulate the collimator to a +90° beam-left position and slowly angulate it to 20° down below horizontal (+70° from vertical).

LED-1 must be on at +90° and remain on for 11° below horizontal (+79°).

3.2.2 Angulate the collimator to a −90° beam-right position and slowly angulate it to 20° down below horizontal (−70° from vertical).

LED-5 must be on at −90° and remain on for 11° below horizontal (−79°).

IF COLLIMATOR TILT SWITCH DOES NOT CHECK OUT, REFER TO MASTER BOARD SCHEMATIC 70-08009

3.3 TABLE TILT SWITCH CHECKOUT (FOR TILTING TABLES ONLY)

Remove the jumper between TS2-5 and TS2-10. Angulate the collimator to 0° beam-down. Angulate the table to 0° horizontal and slowly tilt it to +20° and then −20°.

LED-4, Figure 3.1, must be on with the table at 0° and remain on for +11° and −11° from horizontal.

3.3.1 Position the table at +90° upright (usually about an actual +85°) and angulate the collimator to a +90° (LED-1 "ON") beam-left position. Slowly tilt the table 20° down from the maximum upright position (+70°).

LED-7, Figure 3.1, must be ON at a maximum upright and remain ON until the table is angulated down to +79°. (LED-1 will also be ON).

3.3.2 Angulate the table to −90° trendellenberg and angulate the collimator to −90° beam-right (LED-5 ON). Slowly tilt the table 20° down from the maximum trendellenberg position.

LED-6, Figure 3.1, must be ON and remain ON until the table is angulated down to −79°. (LED-5 will also be "ON").

3.3.3 The tilt monitors must meet the above requirements in order to comply with Part 1020.31 (d)(2)(i) and 1020.31 (e)(1)(ii) of the Performance Standards.

If the tilt monitors do not pass each requirement listed, corrective action must be taken. DO NOT PROCEED with the testing until all requirements are met. Refer to Section 2.5.8, Figure 2.10 and 2.11 and Schematic 70-08009.

3.4 LOGIC AND COLLIMATOR OPERATION CHECKOUT –(Using Internal Signals)

NOTE: Cassette tray must be removed for the following procedures.

NOTE: SW2-1 through 4 and SW3-1 through 4 must be "OFF".

Angulate the table to 0° horizontal and the collimator to 0° beam-down position. LED-4 on the Logic P.C.B. must be ON.

Using a steel measuring rule, measure the distance from the center of the plastic exit window to the center of the cassette tray (Image Receptor). Set this distance to 30⅝" ± 1⁄16" in order to achieve 40" focal spot to table top distance.

A. The ON and MANUAL indicators on the collimator front panel should be ON.

B. LED-2, Figure 3.1, on the Logic P.C.B. should be ON.

3.4.1 Set SW2-1 and SW2-3 "ON" to simulate a 14" x 14" cassette. Set SW3-4 "ON" to simulate the insertion of cassette in the cassette tray.

A. LED-2 (IR TRUE) should switch OFF.

B. The MANUAL indicator should switch OFF.

C. The HOLD indicator should switch ON.

3.4.2 Set SW3-2 "ON" to simulate a 40" SID switch closure. Move the front panel sliding SID scale knob to the 40" detented position.

A. The 40" indicator should switch ON.

B. The collimator field size indicators (front panel) should rapidly adjust to about 14" x 14" and stop.

C. The HOLD indicator should switch OFF.

D. The READY indicators should switch ON.

E. The light field size on the table top (40") should be about 14" x 14". Use test pattern 70-09015 supplied with this manual.

3.4.3 Set SW3-2 "OFF" (opening of 40" SID switch).

A. The 40" indicators should switch OFF.

B. The READY indicators should switch OFF.

C. The HOLD indicator should switch ON.

3.4.4 Set SW3-3 "ON" to simulate 72" SID switch closure.

Move the front panel sliding SID scale knob to the 72" detented position.

A. The 72" indicator should switch ON.

B. The collimator field size indicators (front panel) should rapidly adjust to about 14" x 14" and stop.

C. The HOLD indicator should switch OFF.

D. The READY indicators should switch ON.

E. The light field size on the table top (40") should be about 7.8" x 7.8" (14" x 14" at 72" with a .56 reduction due to 40" positioning). Use test pattern 70-09015 supplied with this manual.

3.4.5 Set SW3-3 "OFF" (opening of 72" SID switch).

A. The 72" SID indicator should switch OFF.

B. The READY indicators should switch OFF.

C. The HOLD indicator should switch ON.

3.5 EXTERNAL SID SIGNAL CHECKOUT (HORIZONTAL)

Angulate the collimator to 90° with the x-ray beam at the wall mounted cassette holder. Angulate the table to 0° horizontal.

3.5.1 If the cassette holder is on the wall adjacent to the head-end of the table, this requires the collimator to be at +90° beam-left.

A. LED-1 on the Logic P.C.B. must be ON. (Figure 3.1).

B. Set SW3-5 "ON" on the Logic P.C.B. to select left-wall operation (Figure 3.2).

3.5.2 If the cassette holder is on the wall adjacent to the foot-end of the table, this requires the collimator to be at −90° beam-right.

A. LED-5 on the Logic P.C.B. must be ON (Figure 3.1).

B. Set SW2-5 "ON" on the Logic P.C.B. to select right-wall operation (Figure 3.2).

NOTE: If the wall mounted cassette holder is on the wall adjacent to the head end of the table, leave SW3-5 ON and SW2-5 OFF.

If it is on the wall adjacent to the foot end of the table, leave SW3-5 OFF and SW2-5 ON. Only one switch is to be closed at a time.

3.5.3 Move the collimator horizontally until the distance from the source (focal spot) to image receptor (film in cassette) is at a 72" SID. Slowly move the collimator to a greater and then to a lesser SID while measuring the actual SID.

The 72" indicator on the collimator must be ON at a measured 72" SID and must switch OFF at a maximum of 72.75" and OFF again at a minimum of 71.25" SID.

3.5.4 Move the collimator horizontally to a 40" SID, and slowly move the collimator to a greater and then to a lesser SID.

The 40" indicator on the collimator must be ON at a measured 40" SID and must switch OFF at a maximum of 40.40" and OFF again at a minimum of 39.60" SID.

3.6 TILTING TABLE RECEPTOR SID SIGNAL CHECKOUT – (FOR TILTING TABLES ONLY)

Angulate the table to a full upright position. Angulate the collimator beam-left to aim the x-ray beam at the upright table cassette tray. LED-7 on the logic P.C.B. must be ON (Figure 3.1).

3.6.1 Move the collimator horizontally to a 40" SID, and slowly move the collimator to a greater and then to a lesser SID.

The 40" indicator on the collimator must be ON at a measured 40" SID and must switch OFF at a maximum of 40.40" and OFF again at a minimum of 39.60" SID.

3.7 EXTERNAL IR SIGNALS CHECKOUT (TILTING OR NON-TILTING TABLES

Set the switches on the logic PCB shown in Figure 3.2 as follows:

SW3-1	OFF		SW4-1	OFF
SW3-2	OFF		SW4-2	OFF
SW3-3	OFF		SW4-3	OFF
SW3-4	OFF		SW4-4	OFF
SW2-5	ON		SW3-5	Off (Beam-Right Operation)
		or		
SW2-5	OFF		SW3-5	ON (Beam-Left Operation)

Angulate the collimator 0° beam-down direction with a measured SID of 40" measured to the bucky. For tilting tables, angulate the table to 0° horizontal.

A. The MANUAL indicator should be ON.
B. LED-2 on the Logic P.C.B. should be ON. (Figure 3.1)
C. The 40" indicator should be ON.

3.7.1 Locate a cassette in the table cassette holder and fully insert the tray into the bucky.

A. The MANUAL indicator should switch OFF.
B. The HOLD indicator switch ON.
C. LED-2 on the Logic P.C.B. should switch OFF. (Figure 3.2)
D. The collimator field size indicators (front panel) should rapidly adjust and stop.
E. The HOLD indicator should switch OFF.
F. The READY indicators should switch ON.
G. The light field size on the table-top should be about the same size as the cassette inserted into the cassette tray. (Do not remove the cassette at this time).

3.7.2 Angulate the collimator to properly aim at the wall cassette holder with the Horizontal SID at about 50".

NOTE: Although the cassette was left in the table cassette tray, it should not produce an IR TRUE signal (LED-2 should be ON and the MANUAL indicator should be ON).

3.7.3 Fully insert a cassette into the wall cassette holder.

A. LED-2 on the Logic P.C.B. should switch OFF.
B. The MANUAL indicator should switch OFF.
C. The HOLD indicator should switch ON.
D. All SID indicators should be OFF.

3.7.4 Move the collimator horizontally to each of the available SID's (i.e. 40" or 72").

A. An SID indicator should switch ON.
B. The collimator field size indicators (front panel) should rapidly adjust and stop.
C. The HOLD indicator should switch OFF.
D. The READY indicators should switch ON.
E. The light field size should be about the same size as the cassette in the wall cassette holder.

3.7.5 Remove the cassette from the table cassette tray. The removal of the cassette from the table cassette tray should not produce a response.

3.8 FOR TILTING TABLES

Tilt the table to full upright. At +79°, and without a cassette in the table bucky, the following should occur:

A. LED-2 on the Logic P.C.B. should switch ON.
B. The READY indicators should switch OFF.
C. The MANUAL indicator should switch ON.

3.8.1 Angulate the collimator to +90° beam-left position. Insert a cassette into the cassette tray and fully insert the tray into the table bucky.

A. LED-2 on the Logic P.C.B. should switch OFF.
B. The HOLD indicator should switch ON.
C. The MANUAL indicator should switch OFF.

3.8.2 Move the collimator horizontally to each of the available SID's to the tilted table (i.e., 40" or 72").

A. An SID indicator should switch ON.
B. The collimator field size indicators (front panel) should rapidly adjust and stop.
C. The HOLD indicator switch OFF.
D. The READY indicators should switch ON.
E. The light field size should be about the same size as the cassette inserted into the table cassette tray.

3.8.3 Repeat steps 3.8.1 through 3.8.2 with the table and collimator tilted to −90° beam-right position.

3.9 STEREO/TOMO BYPASS SIGNAL CHECKOUT

Angulate the collimator 0° beam-down direction with a measured SID of 40" measured to the bucky. For tilting tables, angulate the table to 0° horizontal.

A. The MANUAL indicator should be ON.
B. LED-2 on the Logic P.C.B. should be ON. (Figure 3.1)

3.9.1 Locate a cassette in the table cassette holder and fully insert the tray into the bucky.

A. The MANUAL indicator should switch OFF.
B. The HOLD indicator should switch ON.
C. LED-2 on the Logic P.C.B. should switch OFF. (Figure 3.2)
D. The collimator should rapidly adjust and stop.
E. The HOLD indicator should switch OFF.
F. The READY indicators should switch ON.
G. The light field size on the table-top should be about the same size as the cassette inserted into the cassette tray. (Do not remove the cassette at this time).

3.9.2 Activate the Stereo/Tomo switch on the generator.

A. The READY indicators should switch OFF.
B. The MANUAL indicator should switch ON.

3.9.3 Deactivate the Stereo/Tomo switch. The collimator should return to the state as indicated in step 3.9.1.

3.10 INPUT SIGNAL VERIFICATION CHART

The charts located at the end of this section are keyed to the preceding steps and to the signal name appearing on the Logic P.C.B. Schematic 70-08002.

A "logic indicator" is located on the Logic P.C.B. Attach a miniature test lead clip on TP-1 and, by the use of a pointed probe, the logic status can be checked when necessary. A logic "HIGH" will illuminate LED-3 and a logic "LOW" will not illuminate LED-3.

3.11 FINAL TEST SWITCH SETTINGS

At the end of this test procedure, be sure to set the test switches as follows:

SW2-1	**OFF**		**SW3-1**	**OFF**
SW2-2	**OFF**		**SW3-2**	**OFF**
SW2-3	**OFF**		**SW3-3**	**OFF**
SW2-4	**OFF**		**SW3-4**	**OFF**
SW2-5	**ON**		**SW3-5**	**OFF (Beam-Right Operation)**
		or		
SW2-5	**OFF**		**SW3-5**	**ON (Beam-Left Operation)**

(VIRC, IR, TRUE, VISID OUT, VSID IN and VIRL signals are analog and cannot be expressed in "Logic" terms)

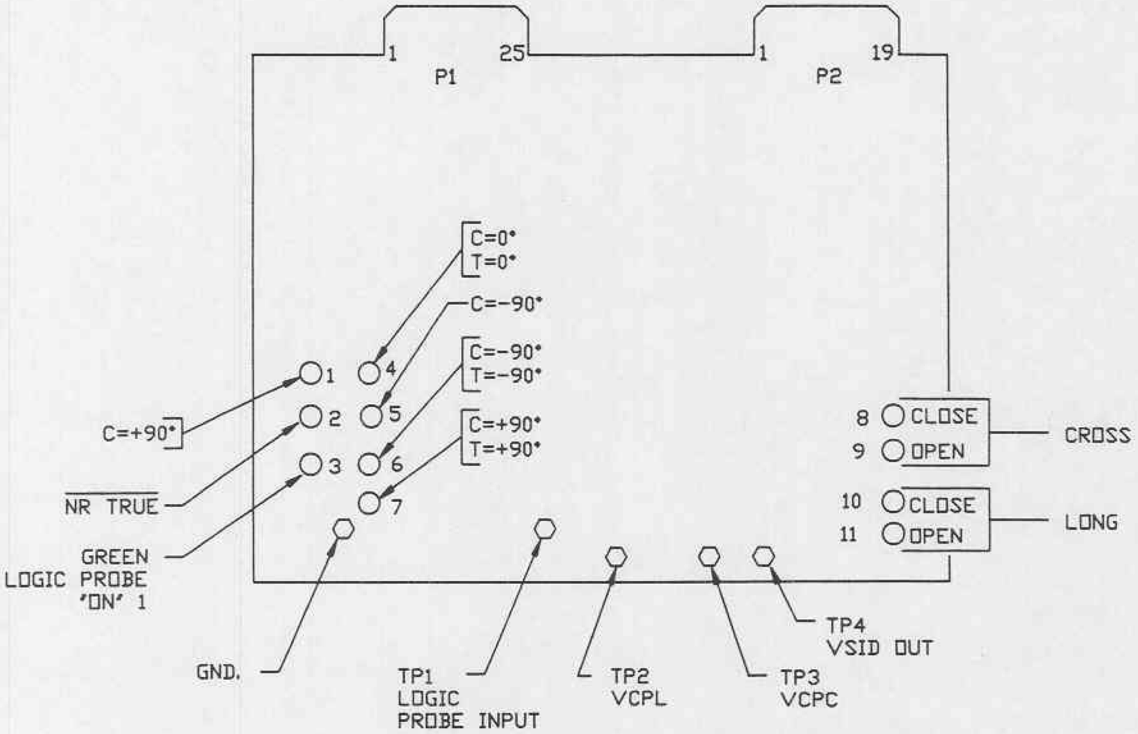
SIGNALS (paragraph ref.)	**3.2**	**3.2.1**	**3.2.2**	**3.3**	**3.3.1**	**3.3.2**	**3.4**	**3.4.1**	**3.4.2**	**3.4.4**	**3.4.6**	**3.4.8**	**3.5**	**3.5.2**
VIRC (TS4-7), VIRL (TS4-5)														
$\overline{\text{STEREO/TOMO}}$ (TS4-11)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
$\overline{C = 0^\circ, T = 0^\circ}$ (TS3-10)	0	1	1	0	1	1	0	0	0	0	0	0	0	0
$\overline{C = +90^\circ}$ (TS3-6)	1	0	1	1	0	1	1	1	1	1	1	1	1	1
$\overline{C = -90^\circ}$ (TS3-7)	1	1	0	1	1	0	1	1	1	1	1	1	1	1
$\overline{C = +90^\circ, T = +90^\circ}$ (TS3-9)	1	1	1	1	0	1	1	1	1	1	1	1	1	1
$\overline{C = -90^\circ, T = -90^\circ}$ (TS3-8)	1	1	1	1	1	0	1	1	1	1	1	1	1	1
IR TRUE														
$\overline{\text{40'' SID}}$ (TS4-14)	1	1	1	1	1	1	1	1	0	1	1	1	1	1
$\overline{\text{72'' SID}}$ (TS4-9)	1	1	1	1	1	1	1	1	1	0	1	1	1	1
EXP. REL. RY (TS4-8)	0	0	0	0	0	0	0	1	0	0	0	0	0	1
$\overline{\text{TABLE LEFT SIDs}}$ (TS4-17)	1	1	1	1	0	1	1	1	1	1	1	1	1	1
$\overline{\text{TABLE RIGHT SIDs}}$ (TS4-15)	1	1	1	1	1	0	1	1	1	1	1	1	1	1
$\overline{\text{WALL L/R SIDs}}$ (TS4-19)	1	0	0	1	1	1	1	1	1	1	1	1	1	1
$\overline{\text{VERT SIDs}}$ (TS4-10)	0	1	1	0	1	1	0	0	0	0	0	0	0	0

Table 3-1 **LINEAR II Logic Chart**

"X" – Don't Care

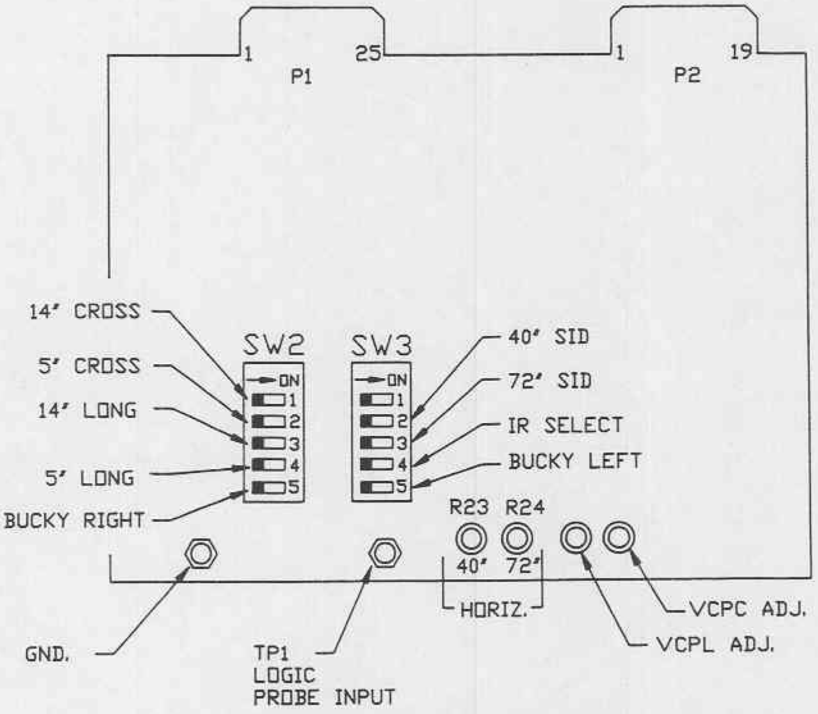
"1" – Logic High (+15 v)

"0" – Logic Low (0 v)


1
25
P1
1
19
P2
C=0°
T=0°
C=-90°
C=-90°
T=-90°
C=+90°
T=+90°
1
2
3
4
5
6
7
C=+90°
NR TRUE
GREEN
LOGIC PROBE
'ON' 1
8 CLOSE
9 OPEN
CROSS
10 CLOSE
11 OPEN
LONG
GND.
TP1
LOGIC
PROBE INPUT
TP2
VCPL
TP3
VCPC
TP4
VSID OUT

LOGIC PCB LED LOCATIONS

FIGURE 3.1


1
25
P1
1
19
P2
SW2
SW3
ON
1
2
3
4
5
ON
1
2
3
4
5
14' CROSS
5' CROSS
14' LONG
5' LONG
BUCKY RIGHT
40' SID
72' SID
IR SELECT
BUCKY LEFT
R23
R24
40'
72'
HORIZ.
VCPC ADJ.
VCPL ADJ.
GND.
TP1
LOGIC
PROBE INPUT

LOGIC PCB SWITCH LOCATIONS

FIGURE 3.2

SECTION 4.0

ADJUSTMENT PROCEDURES

4.0 ADJUSTMENT PROCEDURES

The following adjustment procedures are performed with the collimator located in a single fixed position above a test pattern located on the table top.

The adjustments are made while observing the light field edges, therefore, it is necessary to confirm that the light field accurately represents the x-ray field. By establishing a defined light field and exposing a film to produce a density of 1.0, the x-ray field (image) can be compared to the light field.

The Performance Standards 1020.30 (b)(22) and (45) define the edges of the light field as the locus of points at which the illumination is one-fourth of the maximum and the edges of the x-ray field as the locus of points at which the exposure rate is one-fourth of the maximum.

The x-ray field should be determined by exposing a film to a density of 1.0 on the developed image, and observing the points at which the density is just visibly increased above the base fog background of the film.

In a similar manner, the light field edges should be determined by observing the light field on a white background. By observing the points at which the light field is just visibly increased over the background illumination, and comparing this to the x-ray field (and to the tolerance marks on the pattern), comparisons may be made.

PLEASE NOTE

Eureka Collimators have been 100% tested and calibrated at the factory. Our intention is that you will only have to confirm operation, then readjust the SID voltages to match the collimator and the Image Receptor (cassette tray) after the unit is installed.

Section 3 of the Manual (Operational Checkout) walks you through the procedure using internally generated cassette size signals (5" and 14") by selecting appropriate switches located on the logic P.C.B.

There are FACTORY SET adjustments that should NOT be altered. They are R25 (VCPL) and R26 (VCPC) located on the Linear I, II Logic P.C.B. (70-08002). These potentiometers set the voltages to the collimator feedback potentiometers. The voltages control the "Tracking" of the collimator, closed to open, and are extremely critical. If, in the unlikely event that they require adjustment, you can measure VCPL at TP-2 and VCPC at TP-3. The factory set values are recorded on the label inside the bottom cover. R26 controls the voltage to the CROSS feedback potentiometer and is used to "Balance" CROSS to LONG after the correct x-ray field size has been set. Refer to section 5, Steps 5.4 through 5.4.4 for adjustment procedure.

NOTE! Before setting these voltages to a value different from those on the inside cover, verify the calibration of Image Receptors (cassette trays). Refer to Section 4.5.

EQUIPMENT REQUIRED:

A. LINEAR collimator test pattern 70-09015 contained in this manual.
B. Measuring tape (ruler).
C. 14" x 17" x-ray film cassette.
D. Densitometer (or a 1.0 neutral density filter for density comparison).

4.1 LIGHT FIELD / X-RAY CONGRUENCE TEST

Place the x-ray source-to-table distance at 40" SID and lock in place.

4.1.1 Locate a cassette on the table top and accurately center the cassette to the light field. Mark the position of the cassette on the table top.

4.1.2 Manually reduce the size of the x-ray field to the next smaller film size.

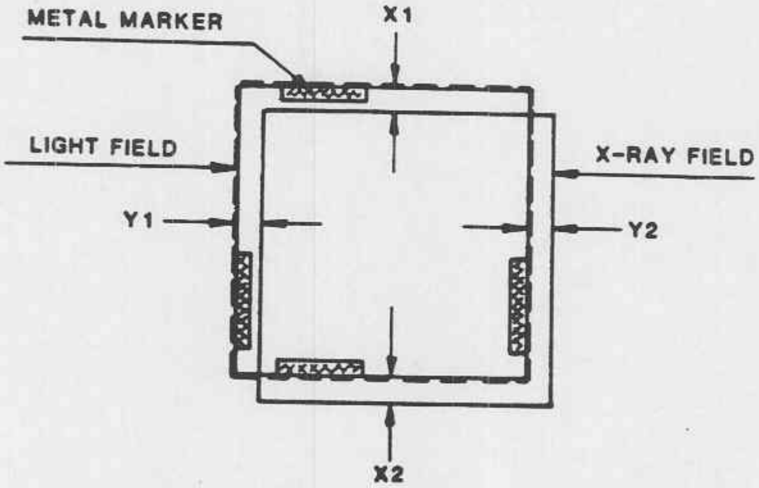
4.1.3 Identify the light-field edges and carefully mark the edges by placing metal markers as illustrated below. See Figure 4.1.

4.1.4 Expose the film to a density of 1.0 and develop.

4.1.5 Carefully identify the x-ray field edges and measure the difference between the x-ray field edges and light field edges.

4.1.6 The sum of long axis difference (X1 + X2) shall not exceed 2% of the SID, and the sum of the cross axis difference shall not exceed 2% of the SID. See Figure 4.1.

4.1.7 If adjustment is required, refer to Section 5.0, 5.1 through 5.1.8.



X1 + X2 MUST BE LESS THAN 2% OF THE SID

Y1 + Y2 MUST BE LESS THAN 2% OF THE SID

LIGHT FIELD VS. X-RAY FIELD CONGRUENCY
FIGURE 4.1

4.1.8 Angulate the collimator to 0° beam-down position and the table top to 0° horizontal.

Remove the LINEAR collimator table-top TEST PATTERN 1 (70-09015) from this manual and position it on the table-top with the edges parallel to the table-top edges. Flatten the creases and tape it into position at the corners in a manner that will not damage it upon removal. (Figure 4.1)

4.1.9 Position the collimator at a focal spot distance of 40" ± 1/16" by measuring from the center of the exit window to the center of the light field on the table top; this distance should be 30 5/8" ± 1/16".

If necessary, remove the bottom collimator cover to gain access to the program switches on the Logic P.C.B. See COVER REMOVAL INSTRUCTIONS, Figure 3.0, Section 3.

4.2 40" SID ADJUSTMENT

Be certain there is no cassette in the table bucky! Set SW3-2 "ON" to simulate 40" HSID. (See Figure 4.1)

4.2.1 Set SW2-1 and SW2-3 "ON" to simulate a 14" x 14" cassette.

4.2.2 Set SW3-4 "ON" to simulate the insertion of the 14" x 14" cassette in the cassette tray.

4.2.3 The light field edges should now be inside the 14" x 14" at 40" SID tolerance marks on TEST PATTERN 70-09015.

4.2.4 If the light field edges are not within the 14" x 14" at 40" SID tolerance marks, adjust the 40" SID pot R23 a small amount (7.0 vdc nominal on TP-4, IC3, pin 1, Logic P.C.B. or TS3-4, Power Supply Chassis). Manually turn the collimator knobs to a larger size and release.

4.2.5 The shutters will become reset to the new size caused by adjusting R23.

4.2.6 Repeat steps 4.2.4 and 4.2.5 until the light field edges are within the 14" x 14" at 40" SID tolerance marks.

4.3 Collimator Feedback Linearity Test

The following tests will quickly confirm the correct factory settings of the shutter feedback potentiometers by simulating a 14" x 14" cassette, then simulating a 5" x 5" cassette. The "errors" of each of these field sizes must be the same.

EXAMPLE 1

Field size, Step 4.3.1 = 14.5" × 14.5" = +0.5" error

Field size, Step 4.3.5 = 5.5" × 5.5" = +0.5" error

CONCLUSION: Errors are consistent, collimator passes linearity test, proceed with Step 4.3.7.

EXAMPLE 2

Field size, Step 4.3.1 = 13.7" × 13.7" = −0.3" error

Field size, Step 4.3.5 = 5.4" × 5.4" = +0.4" error

CONCLUSION: Errors are inconsistent, collimator fails linearity test, skip to Section 5 and check VCPL and VCPC, Steps 5.4 through 5.4.4. If VCPL and VCPC are correct, replace the collimator head.

EXAMPLE 3

Field size, Step 4.3.1 = 13" x 14" = (Testing Stopped)

CONCLUSION: Errors in only one field size test inconsistent, resulting in a "rectangular" x-ray field size, collimator fails test. Skip to Section 5 and check VCPL and VCPC, Steps 5.4 through 5.4.4. If VCPL and VCPC are correct, replace the collimator head.

4.3.1 The light field should now be measured in the CROSS direction and the LONG direction and recorded. The CROSS size must match the LONG size within ±0.20".

4.3.2 Set SW3-4 "OFF" (Cassette removal).

4.3.3 Set SW2-1 and SW2-3 "OFF" then set SW2-2 and SW2-4 "ON" (exchanging 14" x 14" IR with a 5" x 5" IR).

4.3.4 Set SW3-4 "ON" to simulate the insertion of the 5" x 5" cassette in the cassette tray. Allow the system to readjust until both READY lights come on.

4.3.5 The light field should now be measured in the CROSS direction and the LONG direction and recorded. The CROSS size must match the LONG size within ±0.20".

4.3.6 If the measurement in Steps 4.3.1 and 4.3.5 are within ±0.20" skip to Step 4.3.7. If the measurements differ by more than ±0.20", skip to Section 5, Steps 5.4 through 5.4.4 and check VCPL and VCPC. If they are correct, replace the collimator head.

If the light field errors in Step 4.3.1 are more than 0.20" greater, or 0.20" less than the errors in Step 4.3.5, skip to Section 5, Steps 5.5 through 5.5.4 and check VCPL and VCPC. If they are correct, replace the collimator head.

4.3.7 Set SW3-4 "OFF" (removal of cassette).

4.3.8 Set SW-2-2 and SW-2-4 "OFF", then set SW2-1 and SW2-3 "ON" (exchanging 5" x 5" IR with 14" x 14" IR). Set SW3-4 "ON" (insertion of cassette).

4.4 72" SID Adjustment

Set SW3-2 "OFF" and set SW3-3 "ON" (exchanges 40" SID switch with 72" SID switch). Set SW3-4 "ON" to simulate the insertion of the 14" x 14" cassette in the cassette tray. Allow the system to readjust until both READY lights are ON.

4.4.1 The light field edges should now be inside the 14" x 14" at 72" SID tolerance marks on TEST PATTERN 70-09015.

4.4.2 If the light field edges are not within the 14" x 14" at 72" SID tolerance marks, adjust 72" SID pot R24 a small amount, (4.39 vdc nominal on TP-4, IC3, pin 1, Logic P.C.B. or TS3-4, Power Supply Chassis). Manually turn the collimator knobs to a larger size and release. Repeat the adjustment until the light field edges are within the 14" x 14" at 72" SID tolerance marks.

NOTE: At the end of this adjustment procedure re-set the test switches as follows:

SW2-1 – OFF
SW2-2 – OFF
SW2-3 – OFF
SW2-4 – OFF
SW2-5 – BEAM RIGHT (WALL BUCKY) ON FOR RIGHT OFF FOR LEFT

SW3-1 – OFF
SW3-2 – OFF
SW3-3 – OFF
SW3-4 – OFF
SW3-5 – BEAM LEFT (WALL BUCKY) OFF FOR RIGHT ON FOR LEFT

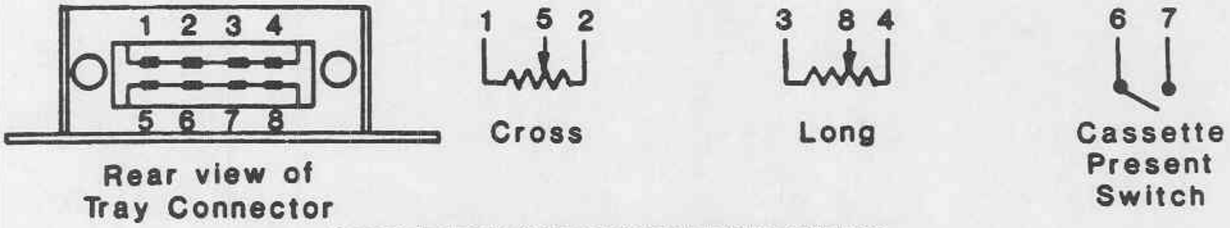
4.5 CASSETTE TRAY ADJUSTMENT

PLEASE NOTE! With tilting tables, the table and wall cassette tray potentiometers must be set exactly the same because there is only one HSID adjustment in the collimator for a given distance to either bucky.

We have calibrated the collimator around a cassette tray that is calibrated at 500 ohms for an 11 inch (12⅛" outside) cassette. The 11" dimension represents exactly one-half of the 1K ohm cassette tray potentiometer. We strongly suggest that you check, and adjust if necessary, your cassette trays. Consult the tray manufacturer's manual for adjustment procedures.

Following is the size vs. ohms chart:

Cassette Size	Ohms Between Pins 1-5 and 4-8
5"	60 Ohms
7	207
8	280
10	427
11	500
12	573
14	720
17	940



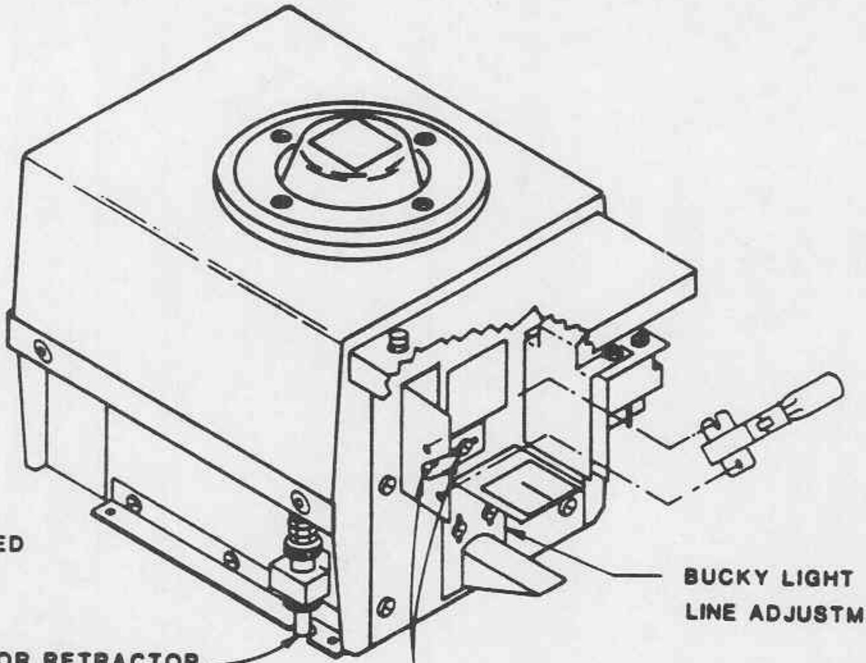
CASSETTE TRAY POTENTIOMETER WIRING

Figure 4.2

NO TEXT

SECTION 5.0

ALIGNMENT PROCEDURES



COVER REMOVED

MIRROR RETRACTOR

BUCKY LIGHT LINE ADJUSTMENT

CROSS ALIGNMENT

1. LOOSEN LOWER KNURLED KNOB
2. ADJUST UPPER KNURLED KNOB FOR LIGHT FIELD ALIGNMENT, FRONT TO REAR.
3. TIGHTEN LOWER KNOB

LONGITUDINAL ALIGNMENT

1. SLIGHTLY LOOSEN THE TWO #6-32 SCREWS
2. POSITION LAMP BRACKET LATERALLY FOR LIGHT FIELD ALIGNMENT, LEFT TO RIGHT.
3. TIGHTEN THE TWO SCREWS.

WARNING: THE INTENSITY OF THE LIGHT OUTPUT IS SUFFICIENT TO TEMPORARILY IMPAIR YOUR VISION IF ALLOWED TO ENTER DIRECTLY INTO YOUR EYES: MAINTAIN A POSITION IN WHICH YOU CAN NEITHER SEE THE FILAMENT WHEN IT IS OFF, OR ALLOW LIGHT TO DIRECTLY ENTER YOUR FIELD OF VISION WHEN IT IS ON.

WARNING: THE LAMP AND HEAT DEFLECTORS MAY BE HOT ENOUGH TO CAUSE SEVERE BURNS: DO NOT TOUCH ANY OBJECT IN THE LAMP AREA WITH BARE SKIN.

LIGHT FIELD AND BUCKY LIGHT LINE ADJUSTMENT

FIGURE 5.1

5.0 ALIGNMENT PROCEDURES

5.1 FIELD PROJECTION LAMP AND MIRROR ADJUSTMENT

These tests must be performed when the field projection lamp is altered from its original position or is replaced.

These tests must also be performed if the original mirror angle has been altered and if any edge of the developed x-ray image is outside of the tolerance marks as defined in Step 4.1.6.

5.1.1 Steps 4.1 through 4.1.6 should be carefully reviewed or repeated prior to a lamp or mirror adjustment attempt. This is particularly important if only a single testing indicates a failure to meet the requirements defined in Step 4.1.6.

5.1.2 The collimator position and the developed x-ray film must remain undisturbed from the position defined in Steps 4.1 through 4.1.9.

5.1.3 Remove the lamp housing cover and bottom collimator cover. See Figure 3.0 and Figure 5.1.

WARNING! THE LAMP AND HEAT DEFLECTORS MAY BE HOT ENOUGH TO CAUSE SEVERE BURNS. DO NOT TOUCH ANY OBJECT IN THE LAMP AREA WITH BARE SKIN.

WARNING! THE INTENSITY OF LIGHT OUTPUT IS SUFFICIENT TO TEMPORARILY IMPAIR YOUR VISION IF ALLOWED TO ENTER THE EYES DIRECTLY. MAINTAIN A POSITION IN WHICH YOU CAN SEE NEITHER THE FILAMENT WHEN IT IS OFF, OR ALLOW LIGHT TO DIRECTLY ENTER YOUR FIELD OF VISION WHEN IT IS ON.

5.1.4 If the developed x-ray image (Step 4.1.6) is off-center in the longitudinal direction, loosen the two screws securing the lamp bracket. (Figure 5.1)

5.1.5 Use a pair of long-nose pliers to move the bracket slightly until the light-field has shifted to a position that is centered to the developed x-ray image (4.1.6) in the longitudinal direction. Tighten the two screws securing the lamp bracket.

5.1.6 If the developed x-ray image (Step 4.1.6) is in error in the cross-table direction, adjust the angle of the mirror (using the knurled knobs as shown in Figure 5.1) until the light-field has shifted to a position that is centered to the developed x-ray image (4.1.6).

5.1.7 Repeat Steps 4.1 through 4.1.8 to confirm the results of the above adjustments.

5.1.8 Tighten the lamp bracket screws and replace the lamp housing cover.

5.2 CROSS-HAIR WINDOW ADJUSTMENT

5.2.1 These procedures are to be performed if the cross hair shadows are not centered to the light-field.

5.2.2 Remove the cone-adaptor rails and the lower half of the collimator case (Figure 3.0).

5.2.3 Loosen the screws securing the plastic window.

5.2.4 Move the plastic window to align and center the cross hair pattern to the light-field (center lines on the test pattern).

5.2.5 Tighten the screws and reassemble the collimator cover.

5.3 BUCKY CENTERING LIGHT-LINE ADJUSTMENT

These procedures are to be performed if the centering light-line is not centered to the correctly adjusted light-field.

5.3.1 Remove the lamp housing cover.

WARNING! THE LAMP AND HEAT DEFLECTORS MAY BE HOT ENOUGH TO CAUSE SEVERE BURNS. DO NOT TOUCH ANY OBJECT IN THE LAMP AREA WITH BARE SKIN.

WARNING! THE INTENSITY OF LIGHT OUTPUT IS SUFFICIENT TO TEMPORARILY IMPAIR YOUR VISION IF ALLOWED TO ENTER THE EYES DIRECTLY. MAINTAIN A POSITION IN WHICH YOU CAN SEE NEITHER THE FILAMENT WHEN IT IS OFF, OR ALLOW LIGHT TO DIRECTLY ENTER YOUR FIELD OF VISION WHEN IT IS ON.

5.3.2 If the centering light-line is off-center to the correctly centered light-field or exhibits a rainbow of colors along one edge, loosen the two screws securing the prism/slit bracket (Figure 5.1.4).

5.3.3 Use a pair of long-nose pliers to move the bracket as required to center the light-line to the correctly adjusted light-field.

NOTE: In order to avoid a rainbow of color along the edges, or to eliminate these colors, maintain the prism in a position that is centered to the bright light-line observed on the bracket at the base of the prism while adjusting the bracket.

5.3.4 Tighten the screws and replace the lamp housing cover.

5.4 COLLIMATOR POTENTIOMETER VOLTAGE ADJUSTMENT (VCPL, VCPC)

NOTE: R25 is factory set and should not be altered in normal circumstances. This adjustment control controls the tracking, open to close, of the shutters.

5.4.1 Connect a DVM from logic ground to TP2 (VCPL).

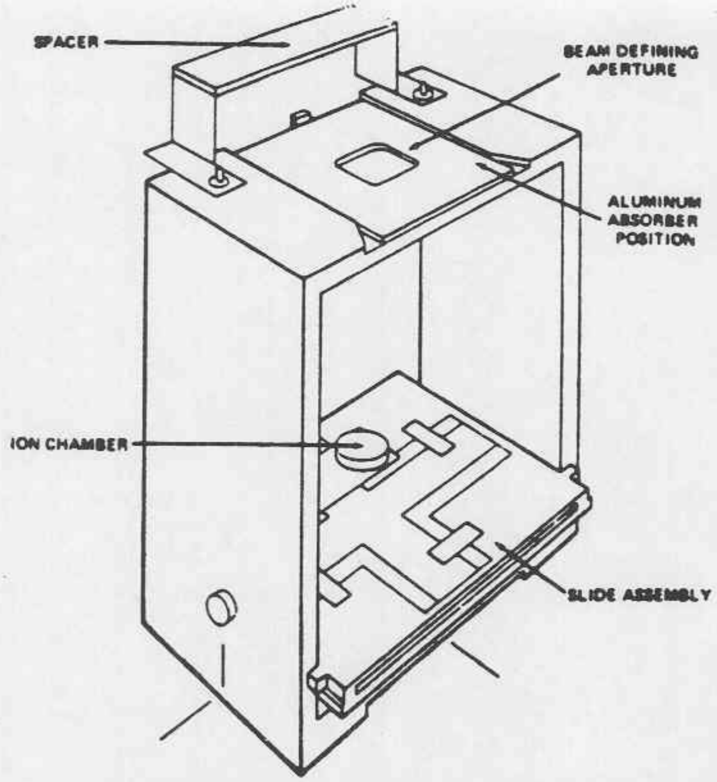
5.4.2 Adjust R25 to produce the voltage reading that has been recorded on the label inside the lower plastic cover (Approximately 11.8 vdc).

5.4.3 With VCPL voltage correctly adjusted, connect the DVM from logic ground to TP3 (VCPC).

5.4.4 Adjust R26 to produce the voltage reading that has been recorded on the label inside the lower plastic cover (approximately 9.7 vdc).

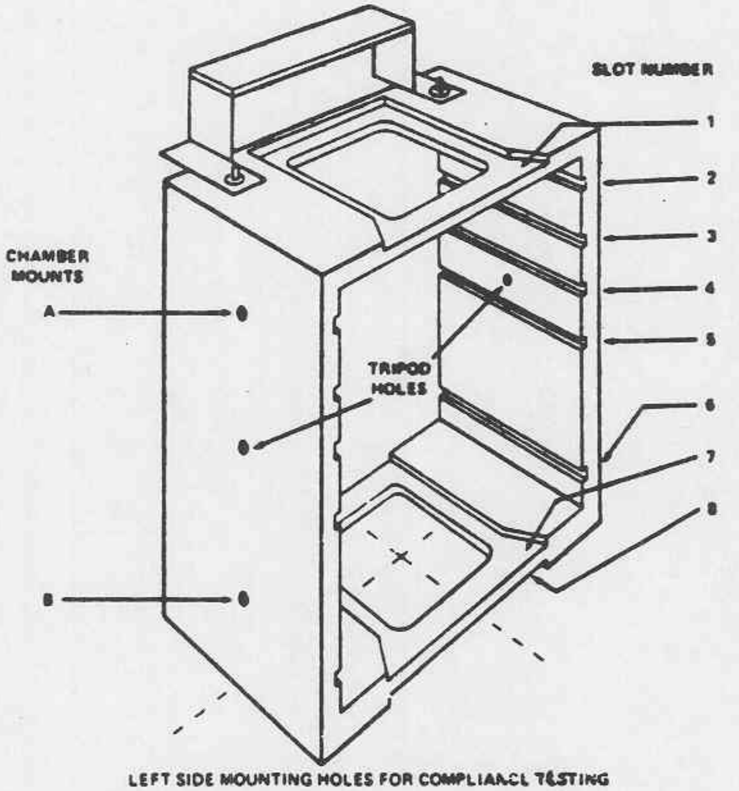
SECTION 6.0

COMPLIANCE VERIFICATION


SPACER
BEAM DEFINING APERTURE
ALUMINUM ABSORBER POSITION
ION CHAMBER
SLIDE ASSEMBLY

BRH/FDA COMPLIANCE TEST STAND

Figure 6.1


SLOT NUMBER
1
2
3
4
5
6
7
8
CHAMBER MOUNTS
A
B
TRIPOD HOLES
LEFT SIDE MOUNTING HOLES FOR COMPLIANCL TESTING

COMPLIANCE STAND DETAIL

Figure 6.2

6.0 COMPLIANCE VERIFICATION

It is necessary for the assembler to verify compliance. A series of tests, when performed at the time of installation, will indicate compliance with 21CFR, Sub-Chapter J, Part 1020, Performance Standards.

The following tests are from the NEMA Standards Publication, No. XR 8-1979 (Test Methods for Diagnostic X-ray Machines for use during initial installation).

For each compliance item, there may be a variety of test methods described. Which method is used will depend on the tester's experience, availability of equipment, time, or special requirements of the Eureka Linear Collimator. Any reference to tolerances on compliance items are referenced directly from 21 CFR, Sub-Chapter J, Regulations. They do not take into account inaccuracies brought about by the test equipment, instrumentation, or the human element. These factors must be considered when these tests are performed and the compliance of the equipment is being determined.

6.1 VERIFICATION TESTS TO BE PERFORMED:

Test Procedure or Requirement	Applicable Paragraph
1. Visual Definition of X-ray Light-Field	XR8/2.14
2. Intensity of Light-Field Illumination	XR8/2.15
3. Minimum Field Size	XR8/2.16
4. X-ray Field/Receptor Center Alignment	XR8/2.17
5. Indication of Field Size	XR8/2.18
6. Positive Beam Limitation (PBL)	XR8/2.19
7. X-ray Field Limitation and Alignment	XR8/2.20
8. Return to PBL with Image Receptor Change	XR8/2.21
9. Keylock PBL Override	XR8/2.22
10. Beam Quality	XR8/2.09

RECORD THE RESULTS ON THE *RECORD SHEET* SUPPLIED AT THE END OF THIS SECTION.

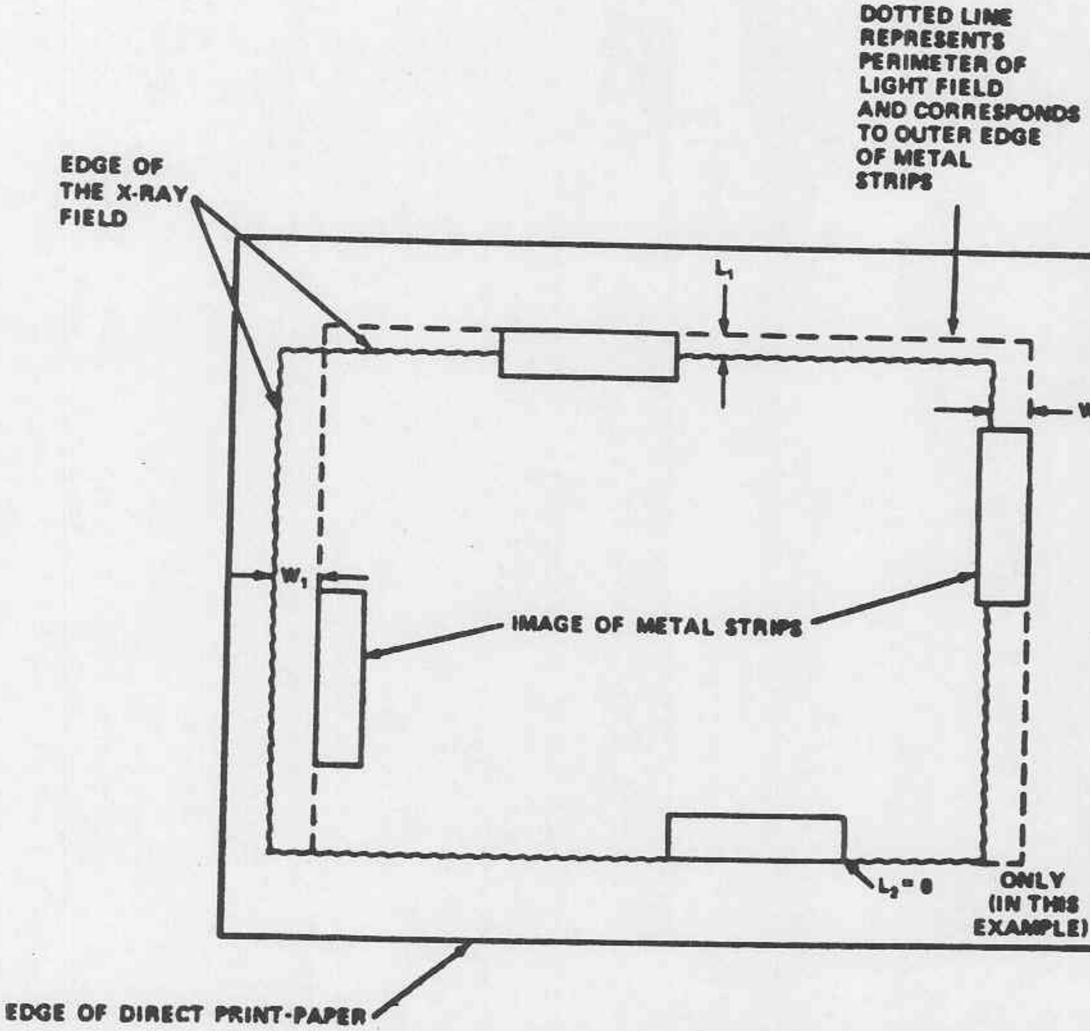
RADIATION ☢ WARNING FOR DIAGNOSTIC X-RAY SYSTEMS

X-rays are dangerous to both operator and others in the vicinity unless established safe exposure procedures are strictly observed.

The useful and scattered beams can produce serious, genetic or potentially fatal bodily injuries to any persons in the surrounding area if used by an unskilled operator. Adequate precautions must always be taken to avoid exposure to the useful beam, as well as to leakage radiation from within the source housing or to scattered radiation resulting from the passage of radiation through matter.

Those authorized to operate, test, participate in or supervise the operation of the equipment must be thoroughly familiar and comply completely with the currently established safe exposure factors and procedures described in publications such as Sub-Chapter J of Title 21 of the Code of Federal Regulations, *"Diagnostic X-ray Systems and their Major Components"*, and the National Council on Radiation Protection (NCRP) No. 33, *"Medical X-ray and Gamma-ray Protection for Energies up to 10 MeV-Equipment Design and Use"*, as revised or replaced in the future.

Failure to observe these warnings may cause serious, genetic or potentially fatal bodily injuries to the operator or those in the area.


DOTTED LINE REPRESENTS PERIMETER OF LIGHT FIELD AND CORRESPONDS TO OUTER EDGE OF METAL STRIPS
EDGE OF THE X-RAY FIELD
L_1
W_2
W_1
IMAGE OF METAL STRIPS
$L_2 = 0$
ONLY (IN THIS EXAMPLE)
EDGE OF DIRECT PRINT-PAPER

LIGHT FIELD VS. X-RAY FIELD ERROR MEASUREMENTS

Figure 6.3

XR 8-2.14 VISUAL DEFINITION (RADIOGRAPHIC) OF X-RAY LIGHT FIELD

REQUIREMENT – Means shall be provided for visually defining the perimeter of the X-ray field. The total misalignment of the edges of the visually defined field with the respective edges of the X-ray field along either the length or width of the visually defined field shall not exceed 2 percent of the distance from the source to the center of the visually defined field when the surface upon which it appears is perpendicular to the axis of the X-ray beam. [See 21 CFR 1020.31(d)(2).]

.01 METHOD I — BRH/FDA COMPLIANCE TEST METHOD

A. EQUIPMENT REQUIRED

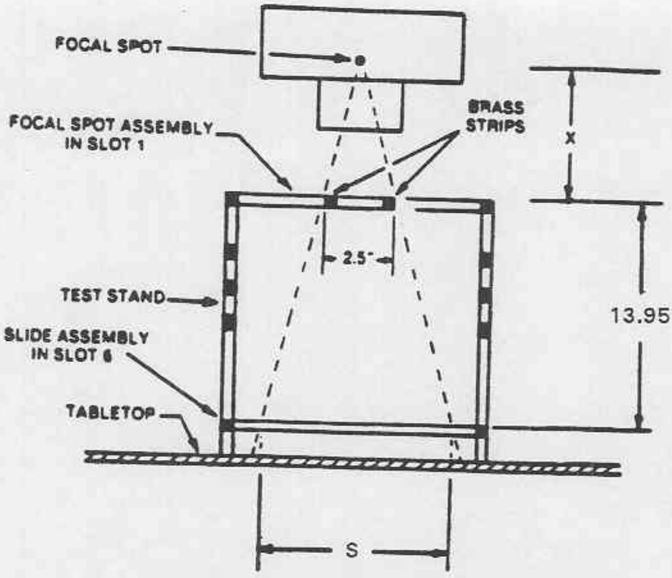
1. BRH/FDA compliance test stand (including slide assembly).
2. Four metal marker strips.
3. Plastic cassette, loaded with direct-print paper or film.

B. PROCEDURE ☢

1. Attach the spacer, positioned out of the primary beam to the test stand. Center the stand on the table. Center the source over the stand, assure by the means provided that the axis of the X-ray beam is perpendicular to the plane of the image receptor, and bring the beam-limiting device down into firm contact with the spacer. Select the MANUAL mode of operation (there must not be a cassette in the cassette holder).
2. Insert the slide assembly, grid side up, into slot 6 of the test stand and the focal spot assembly into slot 1 (Fig. 6-2). Place a cassette loaded with direct-print paper or film into the slide assembly.
3. Adjust the collimator such that no part of the light-field intersects any portion of the top of the test stand. (Further collimation to a light-field of less than 15 by 20 centimeters [6 by 8 in] on the slide assembly grid may be desirable to assure that the X-ray field will be fully contained on the direct-print paper or film in the slide assembly).
4. Position the outer edge of each metal strip to correspond with each side of the light-field. One end of the metal strip shall extend to the center line of the respective grid arm.
5. Select proper technique factors and make an exposure (may require several exposures to obtain 1 R to the direct-print paper).
6. Develop the direct-print paper or film.

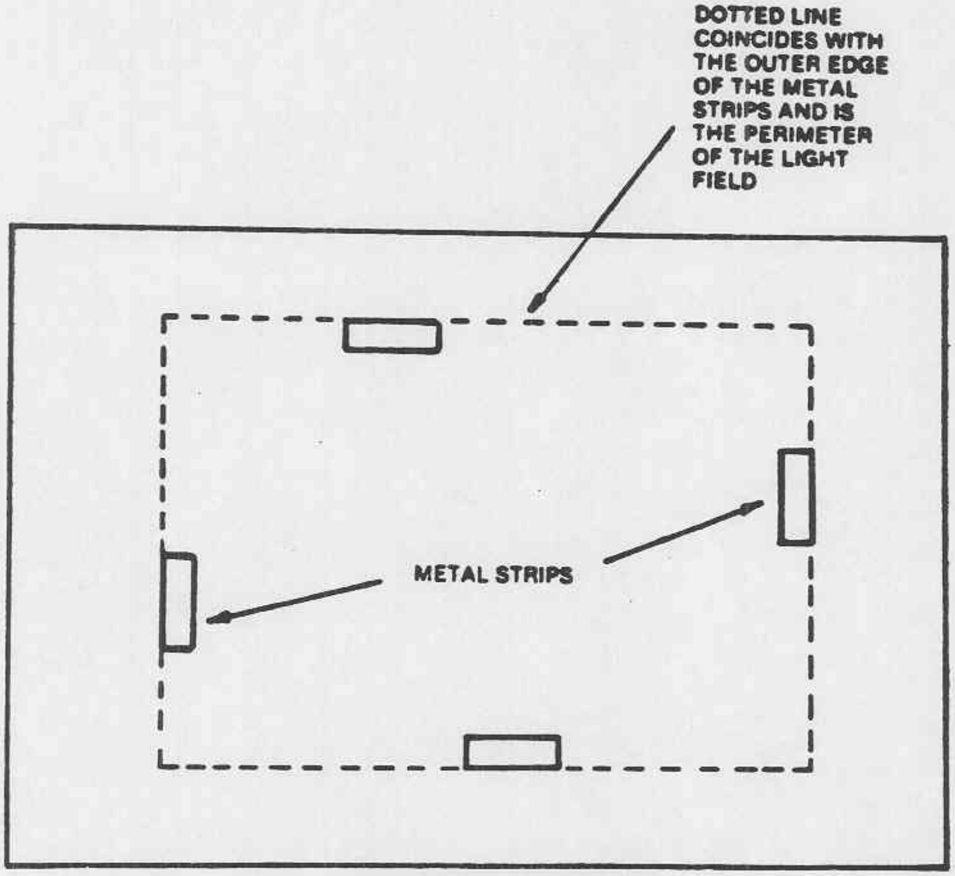
C. VERIFICATION OF COMPLIANCE

For determination of misalignment, compare the edges of the X-ray field to the edges of the light-field as defined by the outer edges of the metal strips. On each side of the rectangular fields, measure the separation between the X-ray field and the outside edge of the image of the respective metal strip. Sum these measured separations for opposite sides of the X-ray field to yield a total misalignment in the length and in the width dimensions. Record the length misalignment and width misalignment, both without regard to sign (see Par. D below and Fig. 6-3).


FOCAL SPOT
FOCAL SPOT ASSEMBLY IN SLOT 1
BRASS STRIPS
X
2.5"
TEST STAND
13.95"
SLIDE ASSEMBLY IN SLOT 6
TABLETOP
S

DETERMINATION OF SID

Figure 6.4


DOTTED LINE COINCIDES WITH THE OUTER EDGE OF THE METAL STRIPS AND IS THE PERIMETER OF THE LIGHT FIELD
METAL STRIPS

METAL MARKER METHOD

Figure 6.5

D. CALCULATIONS

Calculate the source-to-image distance (SID) per the following formula (to slot 6) as the indicated source-to-table top distance minus 4.7 centimeters (1.85 in) and record. Calculate 2 percent of this SID and record. Both the length and the width misalignment must be less than 2 percent of SID (to slot 6).

$$\frac{2.5}{S} = \frac{X}{X + 13.95}$$

$$2.5X + (2.5)\,13.95 = XS$$

$$(2.5)\,13.95 = XS - 2.5X \qquad \text{See Fig. 6-4.}$$

$$34.875 = X\,(S - 2.5)$$

$$X = \frac{34.875}{S - 2.5}$$

The misalignments are calculated:

Length misalignment = $L_1 + L_2 \leqslant 2\%$ SID
Width misalignment = $W_1 + W_2 \leqslant 2\%$ SID

Calculate 2 percent of the measured SID. Each of the misalignments, length or width, must be less than or equal to 2 percent of the measured SID for compliance.

NEMA Standard 5-15-1979.

.02 METHOD II — METAL MARKER METHOD

A. GENERAL

The actual versus indicated source-to-image distance (SID) test must be performed prior to attempting this test.

B. EQUIPMENT

1. Plastic cassette with direct-print paper or film.
2. Radio-opaque markers.*

*Each marker is approximately 1/32 inch galvanized sheet metal having the dimensions of 1.5 by 1.5 inches.

C. PROCEDURE ☢

1. Adjust the source assembly and the beam-limiting device so that they are approximately centered over the table and perpendicular to the table top. Then position the beam-limiting device to the SID previously determined and record the indicated value.
2. Insert the cassette and turn on the light field.** Adjust the beam-limiting device to the next size smaller than the cassette size being used.

**Make a note to record the field size indicated on the dial of the beam-limiting device for the SID being used.

3. Position the outer edge of each metal marker on the table top to correspond with each side of the light-field (Fig. 6-5).
4. Select the appropriate technique factors and make an exposure.
5. Develop film or direct-print paper.

D. VERIFICATION OF COMPLIANCE

For determination of misalignment, compare the edges of the X-ray field to the edges of the light-field as defined by the outer edges of the metal strips. On each side of the rectangular fields, measure the separation between the X-ray field and the outside edge of the image of the respective metal strip. Sum these measured separations for opposide sides of the X-ray field to yield a total misalignment in the length and in the width dimensions. Record the length misalignment and width misalignment, both without regard to sign (See Par. E below and Fig. 6-3).

E. CALCULATIONS

Calculate the SID per the following formula (to slot 6) as the indicated source-to-tabletop distance minus 4.7 centimeters (1.85 in) and record. Calculate 2 percent of this SID and record. Both the length and the width misalignment must be less than 2 percent of SID (to slot 6).

$$\frac{2.5}{S} = \frac{X}{X + 13.95}$$

$$2.5X + (2.5)\ 13.95 = XS$$

$$(2.5)\ 13.95 = XS - 2.5X \qquad \text{See Fig. 6-4.}$$

$$34.875 = X\ (S - 2.5)$$

$$X = \frac{34.875}{S - 2.5}$$

The misalignments are calculated:

Length misalignment = $L_1 + L_2 < 2\%$ SID
Width misalignment = $W_1 + W_2 < 2\%$ SID

Calculate 2 percent of the measured SID. Each of the misalignments, length or width, must be less than or equal to 2 percent of the measured SID for compliance.

NEMA Standard 5-15-1979.

.03 METHOD III — ALTERNATE TEST STAND METHOD

A. GENERAL

1. The image of the radiation field on the film must be of uniform density with sharply defined edges.
2. The graduated template is utilized to minimize the amount of error introduced into the measurement of the X-ray field size.
3. The actual versus indicated source-to-image distance (SID) must be determined prior to performing this test.

B. EQUIPMENT

1. Manufacturer's recommended test stand.
2. Cassettes and film.
3. Graduated template.

C. PROCEDURE ☢

1. Align the tube unit and image receptor and set the SID with the normal operating aids (detents, scales, lights, etc.).
2. Load cassette and insert into image receptor.
3. Close shutters to a size smaller than that of the cassette placed into the image receptor.
4. Position the test stand in accordance with the manufacturer's instructions.
5. Energize the field light and record or define the position of the four light field edges as shown on the graduated template or position four metal markers such that the outer edge of each metal marker corresponds to an edge on each side of the light field or both.
6. Select proper technique factors, make an exposure, and develop film.

D. VERIFICATION OF COMPLIANCE

1. Calculate 2 percent of the actual SID and record.
2. Compare the edges of the X-ray field to the edges of the light-field as defined by the outer edges of the metal markers or by the graduated scale.
3. Measure the distance between the edges of the two fields for each side of the rectangular fields (See Fig. 6-3).
4. Arithmetically sum the misalignment of opposite sides, regardless of sign, of the rectangles, to yield misalignment in each of the two directions.

Length misalignment = $L_1 + L_2 \leqslant 2\%$ SID
Width misalignment = $W_1 + W_2 \leqslant 2\%$ SID

Both the length and the width misalignment must be less than 2 percent SID as calculated in Step 1.

NEMA Standard 5-15-1979 1/3

XR 8-2.15 INTENSITY OF LIGHT FIELD ILLUMINATION

REQUIREMENT – When a light localizer is used to define the X-ray field, it shall provide an average illumination of not less than 160 lux (15 footcandles) at 100 centimeters or at the maximum source-to-image distance (SID), whichever is less. The average illumination shall be based on measurements in the approximate center of each quadrant of the light field. [See 21 CFR 1020.31(d)(2)(ii).]

.01 **METHOD I** — DIRECT TEST

A. GENERAL

1. Make certain that all surfaces in the light path are clean.
2. Reduce ambient light level as much as is feasible.

B. EQUIPMENT

Photometer capable of measuring 160 lux (15 footcandles).

C. PROCEDURE

1. Place the photometer on the tabletop and set the diagnostic source assembly such that the sensing area of the photometer is at 100 centimeters or the maximum SID, whichever is less.
2. Open the beam-limiting device to assure that each quadrant of the light field is larger than the sensing area of the photometer.
3. Refer to the manufacturer's instructions for proper use of the photometer.
4. Turn on the light localizer.
5. At or near the center of a light field quadrant, determine the illuminance by subtracting the ambient light level from the corresponding light level as measured when the light localizer is energized. Do not move the photometer between measurements.
6. Repeat the procedure for the remaining three quadrants.
7. Determine the average illuminance of the four light field quadrants.
8. Record the model number, serial number, and date of calibration of test instrument.

D. VERIFICATION OF COMPLIANCE

Verify that the average illumination is not less than 160 lux (15 footcandles)

NEMA Standard 5-15-1979

.02 METHOD II — INDIRECT TEST

A. GENERAL

1. This indirect test is feasible after the correlation between light output and voltage is made; the manufacturer then specifies a voltage to be measured or adjusted, or both.
2. Make certain that all surfaces in the light path are clean and unobstructed.

B. EQUIPMENT

Digital Voltmeter.

C. PROCEDURE

1. Remove trim covers to gain access to the lamp socket.
2. Verify that the specified lamp is in the socket.
3. With the light-field energized, measure the voltage across the lamp socket terminals.
4. Record the voltage measured.
5. Record the model number, serial number and calibration date of the digital voltmeter.

D. VERIFICATION OF COMPLIANCE

The voltage recorded shall be within the tolerances specified by the manufacturer.

NEMA Standard 5-15-1979

NOTE: THE AC VOLTAGE AT THE LAMP SOCKET MUST NOT BE LESS THAN 19.5 VAC RMS.

XR 8-2.16 MINIMUM FIELD SIZE

REQUIREMENT – Minimum field size at 100 centimeters (radiographic) or the maximm source-to-image distance (SID) (fluoroscopic) shall be less than or equal to 5 by 5 centimeters [See 21 CFR 1020.31(d)(1), 1020.31 (e)(2), and 1020.32 (b)(2).]

.01 METHOD I — FILM METHOD

A. GENERAL

1. The following test is to be used for radiographic, fluoroscopic, and spot-film devices.
2. This procedure need not be performed if it is apparent by visual means that the beam-limiting device can be adjusted to a size less than 5 by 5 centimeters at the specified SID.

B. EQUIPMENT

1. Cassette.
2. X-ray film or direct-print paper.

C. PROCEDURE 1 — RADIOGRAPHIC AND SPOT-FILM DEVICES ☢

1. Adjust the maximum SID obtainable (spot-film devices or 100-centimeter radiographic devices).
2. Adjust the beam-limiting device to the smallest field size obtainable.
3. Load cassette and set proper technique factors.
4. Make an exposure.
5. Process film.

D. PROCEDURE 2 — FLUOROSCOPIC ☢

1. Set fluoroscopic system for maximum SID and lock into position.
2. Remove all compression cones from the beam.
3. With the X-ray beam off, attach beam attenuator to the input surface of the image receptor.
4. Attach cassette to the bottom of the attenuator.
5. Close shutters as far as possible.
6. Set technique factors to assure proper exposure of the film.
7. Make exposure.
8. Process film.

E. VERIFICATION OF COMPLIANCE

Measure the X-ray field produced on film and verify that the field size is less than or equal to 5 by 5 centimeters.

NEMA Standard 5-15-1979.

.02 METHOD II — VISUAL METHOD

A. GENERAL

1. The following tests are to be used for radiographic, fluoroscopic, and spot-film devices.
2. These procedures need not be performed if it is apparent by visual means that the beam-limiting device can be adjusted to a size less than or equal to 5 by 5 centimeters at the specified source-to-image distance (SID).
3. These tests attempt to minimize radiation exposures as well as film processing by utilizing light field visual display, or image display, or visual mechanical movement.

B. EQUIPMENT

Beam attenuator.

C. PROCEDURE 1 — RADIOGRAPHIC

1. Set the tube unit at a distance of 100 centimetes from the image receptor.
2. Pull out the bucky tray and place an unloaded cassette into the tray. *Do not reinsert bucky tray.*
3. Position source assembly over film cassette in the extended bucky tray.
4. Actuate the light field and close shutters to minimum size. If the light is completely blocked from the image receptor no further test is required.
5. Measure the light field size on the cassette of the extended bucky tray.

D. VERIFICATION OF COMPLIANCE

Measured field size must be less than or equal to 5 by 5 centimeters.

E. PROCEDURE 2 — SPOT-FILM/FLUOROSCOPIC ☢

1. Set SID for maximum obtainable and lock in place.
2. Position beam attenuator to intercept entire X-ray beam.
3. Set appropriate technique factors (both spot-film and fluoroscopic).
4. Close shutters to smallest size obtainable and make an exposure.
5. Verify on viewing device that there is no visual indication of radiation. If any radiation field is discernible, Method I must be utilized to determine minimum field size.

F. VERIFICATION OF COMPLIANCE

Verify that no visual indication of the radiation field is discernible.

NEMA Standard 5-15-1979

XR 8-2.17 X-RAY FIELD/RECEPTOR CENTER ALIGNMENT

REQUIREMENT – Means shall be provided to align the center of the X-ray field with respect to the image receptor to within 2 percent of the source-to-image distance (SID). (See 21 CFR 1020.31(e)(1).

A. GENERAL

1. All exposures taken during this test must have a uniform film density of approximately 1.0.
2. Actual versus indicated SID must be determined prior to performing this test.

B. EQUIPMENT

Radiographic cassette loaded with film (8 by 10 inches).

C. PROCEDURE ☢

1. Load cassette with film and place into the bucky tray.
2. Assure that the X-ray beam is perpendicular to the image receptor and centered over the bucky tray.
3. Set the SID to the value determined in the actual versus indicated SID test.
4. Reduce the X-ray field to approximately 6 by 8 inches.
5. Make an exposure and develop film.
6. To determine as accurately as possible the corners of the image recorded on the film, locate two points on each of the four sides of the image. Through the two points on each side draw a straight line. These four lines when extended intersect making a rectangle which is a close approximation of the actual X-ray field. Draw a diagonal across the image to determine the center of the X-ray image.
7. To determine the center of the X-ray film draw diagonals across the film (the point where these two lines cross is the center of the film), or fold the film into quarters (the point where the two folds cross is the center of the film).
8. The distance from the film center mark to the image center mark is measured and recorded as the linear displacement or mis-alignment of the centers of the X-ray field and the image receptor.

D. VERIFICATION OF COMPLIANCE

Verify that this distance is less than or equal to 2 percent of the SID.

NEMA Standard 5-15-1979.

XR 8-2.18 INDICATION OF X-RAY FIELD SIZE

REQUIREMENT – Means shall be provided on the beam-limiting device to indicate field size in the image receptor plane to within 2 percent of the source-to-image distance (SID). [See 21 CFR 1020.31(e)(1).]

A. GENERAL

The actual versus indicated SID test must be performed prior to beginning this test.

B. EQUIPMENT

A 24- by 30-centimeter or a 10 by 12 inch cassette with film.

C. PROCEDURE ☢

1. Set the SID to the value determined in the actual versus indicated SID test.
2. Center the film cassette in the cassette tray and insert into position.
3. Adjust the field size to 15 by 15 centimeters or 8 by 8 inches by means of the numerical indicators on the beam-limiting device.
4. Make an exposure and develop film.
5. Measure and record the length and width dimensions of the image.

D. VERIFICATION OF COMPLIANCE

The deviation of any of the recorded dimensions must not exceed 2 percent of the SID in Step 1.

NEMA Standard 5-15-1979.

XR 8-2.19 POSITIVE BEAM LIMITATION (PBL)

REQUIREMENT – Means shall be provided for positive-beam limitation (PBL) which will, at the source-to-image distance (SID) for which the device is designed, either cause automatic adjustment of the X-ray field in the plane of the image receptor to the image receptor size within five seconds after insertion of the image receptor or, if adjustment is accomplished automatically in a time interval greater then 5 seconds or is manual, will prevent production of X-rays until such adjustment is completed. At SID's at which the device is not intended to operate, the device shall prevent the production of X-rays. [See 21 CFR 1020.31(e)(2).]

A. GENERAL

The PBL requirement must be met if both the beam axis and table angulation are within plus or minus 10 degrees of the horizontal or vertical and the film is used in the cassette tray.

B. EQUIPMENT

Large size cassette.

C. PROCEDURE ☢

1. Set the source assembly to a SID where the PBL system is intended to operate.
2. Place the largest film cassette with which the system is intended to operate into the cassette tray; do not insert cassette tray at this time.
3. Turn on the light localizer and adjust the beam-limiting device to the smallest obtainable field size.
4. Insert the cassette tray and measure the time elapsed from the insertion of the cassette tray with the cassette inserted to the adjustment of the X-ray field to the image receptor size.
5. The adjustment must be accomplished within 5 seconds.
6. If the adjustment is not accomplished within 5 seconds or the beam-limiting device is of the manual type, select low-range values of tube potential and tube current and attempt to make an exposure. The production of X-rays must be prevented until the PBL adjustment is completed.
7. Move the source assembly to a SID where the PBL system is not intended to operate (see manufacturer's specifications) and attempt to make an exposure. Exposures must not be possible.

NEMA Standard 5-15-1979.

XR 8-2.20 X-RAY FIELD LIMITATION AND ALIGNMENT

REQUIREMENT – The X-ray field size in the plane of the image receptor, whether automatically or manually adjusted, shall be such that neither the length nor the width of the X-ray field differs from that of the image receptor by greater than 3 percent of the source-to-image distance (SID) and that the sum of the length and width differences without regard to sign be no greater than 4 percent of the SID, when the equipment indicates that the beam axis is perpendicular to the plane of the image receptor. [See 21 CFR 1020.31(e)(2)(ii).]

.01 METHOD I — BRH/FDA TEST STAND METHOD

A. EQUIPMENT

1. BRH/FDA compliance test stand with accessories.
2. Slide assembly.
3. Plastic cassette containing a sheet of direct-print paper or X-ray film.
4. Ruler.
5. Cassette (preferably 8 by 10 inches or smaller).

B. PROCEDURE ☢

1. Using the means provided, align the source assembly such that the beam axis is perpendicular to the image receptor.
2. Place the test stand on the table.
3. Position the spacer so as not to intersect the primary beam and secure with the pushbutton connectors.
4. Center the source assembly over the test stand using the means provided, e.g., the light-field used to define the X-ray field.
5. Bring the source assembly down into firm contact with the spacer.
6. Center the cassette tray with the source assembly using the means provided, e.g., bucky light.
7. Insert the plastic cassette into the slide assembly. Then insert the slide assembly into slot 5. (See Fig. 6-2.).
8. Center the film cassette in the cassette tray and insert into position. If the positive-beam limitation will not operate at this SID, raise the source assembly and lock in position at the first operable SID.
9. Make an exposure. Develop the image. Measure and record the length and width dimensions of the image.
10. Calculate the field size correction factor as the SID/A where:
    a. SID is the indicated source-to-image receptor distance, and;
    b. A is the indicated source-to-tabletop distance less 7.7 inches. Multiply each of the measured dimensions by the correction factor.

$$\text{X-ray field length at under-table image receptor} = \frac{\text{SID}}{\text{A}} \times (\text{X-ray field length at slot 5})$$

$$\text{X-ray field width at under-table image receptor} = \frac{\text{SID}}{\text{A}} \times (\text{X-ray field width at slot 5})$$

Determine the difference without regard to sign between the corrected length and width dimensions and the corresponding cassette film size dimensions (8 by 10, 5 by 7, etc.). Each of these differences must be less than 3 percent of the SID, and the sum of these differences must be less than 4 percent of the SID.

NEMA Standard 5-15-1979.

.02 METHOD II — ALTERNATE TEST STAND METHOD

A. GENERAL

Prior to performing this test the magnification factor must be determined in accordance with the X-ray/Light Field Alignment Test – Method III.

B. EQUIPMENT

1. Manufacturer's recommended test stand.
2. Cassette with film.

C. PROCEDURE ☢

1. Align the tube unit and image receptor and set SID to the value determined in the actual versus indicated SID test.
2. Insert empty 8 by 10 inch cassette into bucky tray.
3. Position test stand in accordance with manufacturer's instructions.
4. Load a second cassette and place in the designated position.
5. Select the proper technique factors, make an exposure, and develop film.
6. Measure the length and width of the X-ray image on the film.
7. Multiply each measurement by the magnification factor previously determined.

D. VERIFICATION OF COMPLIANCE

Verify that the X-ray field size in the plane of the image receptor does not differ from that of the image receptor by greater than 3 percent of the SID and that the sum of the length and width differences without regard to sign is not greater than 4 percent of the SID.

NEMA Standard 5-15-1979.

.03 METHOD III — CASSETTE METHOD

A. GENERAL

This procedure can be used only when a capability is provided for overriding positive-beam limitation.

B. EQUIPMENT

1. Large cassette with film.
2. Small cassette, empty.

C. PROCEDURE ☢

1. Insert empty smaller cassette into bucky tray.
2. Switch system to the override mode.
3. Remove the smaller cassette and insert the loaded large cassette.
4. Select the proper technique factors, make an exposure, and develop film.
5. Measure the length and width of the X-ray image on the film.

D. VERIFICATION OF COMPLIANCE

Verify that the X-ray field size in the plane of the image receptor does not differ from that of the image receptor (smaller cassette) by greater than 3 percent of the SID and that the sum of the length and width differences without regard to sign is not greater than 4 percent of the SID.

NEMA Standard 5-15-1979.

XR 8-2.21 RETURN TO POSITIVE-BEAM LIMITATION (PBL) WITH IMAGE RECEPTOR CHANGE

REQUIREMENT – Return to positive-beam limitation (PBL) shall occur with a change in image receptor size. [See 21 CFR 1020.31(e)(2)(iii).]

A. EQUIPMENT

Medium size cassette.

B. PROCEDURE

1. Select positive-beam limitation mode.
2. Insert the medium size cassette into the bucky tray and record the field size indication.
3. Collimate down to a field size smaller than the cassette.
4. Remove and reinsert the cassette.

C. VERIFICATION OF COMPLIANCE

Verify that the system has returned to positive-beam limitation. Record the field size indication and verify that it is equal to the previously recorded field size.

NEMA Standard 5-15-1979.

XR 8-2.22 KEY LOCK TO POSITIVE-BEAM LIMITATION OVERRIDE

REQUIREMENT – If a capability is provided to override positive-beam limitation, a key shall be required to override the positive mode, and the key shall be captive while the positive mode is overridden. [See 21 CFR 1020.31(e)(2)(v).]

A. GENERAL

This test can be performed only if a capability is provided for overriding positive-beam limitation.

B. EQUIPMENT

None.

C. PROCEDURE

1. Verify that a key is required in order to select the override mode.
2. Select the override mode using the key.
3. Verify that while in this mode the key is captive.

NEMA Standard 5-15-1979.

XR 8-2.09 BEAM QUALITY (HALF-VALUE LAYER [HVL])

REQUIREMENT – The minimum beam quality requirements listed in Table 6-1 shall be met. [See 21 CFR 1020.30(m).]

.01 METHOD I – VISUAL DETERMINATION OF HALF-VALUE LAYER (HVL)

A. GENERAL

The above HVL requirement will be considered to have been met if it can be demonstrated that the aluminum equivalent of the total filtration in the primary beam is not less than that shown in Table 6-2.

B. EQUIPMENT

None required.

TABLE 6-1 **MINIMUM BEAM QUALITY REQUIREMENTS**

KVp Range	Measured kVp	HVL (mmAl*)
Below 50	30	0.3
	40	0.4
	49	0.5
50 to 70	50	1.2
	60	1.3
	70	1.5
Above 70	71	2.1
	80	2.3
	90	2.5
	100	2.7
	110	3.0
	120	3.2
	130	3.5
	140	3.8
	150	4.1

*Type 1100 aluminum alloy as given in Aluminum Association Publication No. ASD-1, Aluminum Standards and Data.

TABLE 6-2 **ALUMINUM EQUIVALENT OF PRIMARY BEAM TOTAL FILTRATION**

Operating Voltage (kVp)	Total Filtration (mm Al Equivalent)
Below 50	0.5
50 – 70	1.5
Above 70	2.5

C. PROCEDURE

Visually inspect the system and determine the aluminum equivalence of the total filtration in the primary beam. This includes the inherent filtration of the X-ray tube, X-ray tube housing, beam-limiting device, and any additional filtration that may have been added in the useful beam (in fluoroscopic systems the tabletop is included as part of the added filtration).

D. VERIFICATION OF COMPLIANCE

The aluminum equivalence of the total filtration must be equal to or greater than the amount specified in Table 6-2.

·NEMA Standard 5-15-1979

.02 **METHOD II — STANDARD ABSORBER METHOD**

A. GENERAL

This test is to be used when the surveyor cannot remove or see the total filtration equivalence.

The HVL determinations obtained from the following procedures are to be compared with those illustrated in Table 6-1. The HVL in millimeters of aluminum of the system being tested must be greater than or equal to the values shown in Table 6-1.

B. EQUIPMENT

1. Radiation detector.
2. Standard absorber with equivalent filtration of 2.5 millimeters of aluminum.

C. PROCEDURE

1. With the detection device positioned horizontally, an exposure is made at a preselected technique factor of 80 kVp and appropriate mA and time. The reading of the radiation output is recorded.
2. Position a total of 2.5 millimeters of aluminum at the port of the beam-limiting device and repeat the exposure using the same technique factors. Record the radiation output.

   For X-ray units operating at low kVp (less than 50) and for mammography units, it will be necessary to use an aluminum absorber of 0.6 millimeters at 49 kVp.

D. VERIFICATION OF COMPLIANCE

Verify that the radiation output in step 2 is greater than or equal to 50 percent of the radiation output in step 1.

NEMA Standard 5-15-1979.

.03 **METHOD III — BRH/FDA COMPLIANCE TEST**

A. GENERAL

The HVL determinations obtained from the following procedures are to be compared with those illustrated in Table 6-1. The HVL in millimeters of aluminum of the system being tested must be greater than or equal to the values shown in Table 6-1.

B. EQUIPMENT

1. BRH/FDA compliance test stand with accessories (Fig. 6-1).
2. Survey meter adapted for use with stand with an ion chamber.
3. Several sheets of aluminum, each having a thickness of 0.5 or 1.0 millimeter.

C. PROCEDURE

1. Attach the spacer, positioned out of the primary beam, to the test stand. Center the stand on the table. Center the source over the stand and bring the beam-limiting device down into firm contact with the spacer. Select the MANUAL mode of operation (there must not be a cassette in the cassette tray). Insert the beam-defining assembly in slot 1 of the stand with the leaded side up (see Fig. 6-2). Adjust the beam-limiting device so that the X-ray field slightly exceeds the aperture of the beam-defining assembly. Mount the ion chamber at position B with the chamber facing upward. Connect the chamber and meter with the cable provided. Select a tube potential that is commonly used and is in the highest kVp range of the X-ray system.
2. With no added filtration in the beam, make an exposure and record the reading. For all diagnostic X-ray equipment, use Table 6-3 to detemine increments of filtration required to perform the half-value layer procedure. Make an exposure and record the reading for each total thickness.

TABLE 6-3 HIGHEST DESIGN OPERATING RANGE

Total Added Filtration, mm Al		
Below 50kVp	50 – 70 kVp	Above 70 kVp
0.5	1.0	1.5
1.0	1.5	2.5
1.5	2.5	3.5
2.0	3.5	4.5

The recorded data is plotted on semi-log graph paper (Examples A and B, Fig. 6-6) and the half-value layer is read directly from the graph.

D. VERIFICATION OF COMPLIANCE

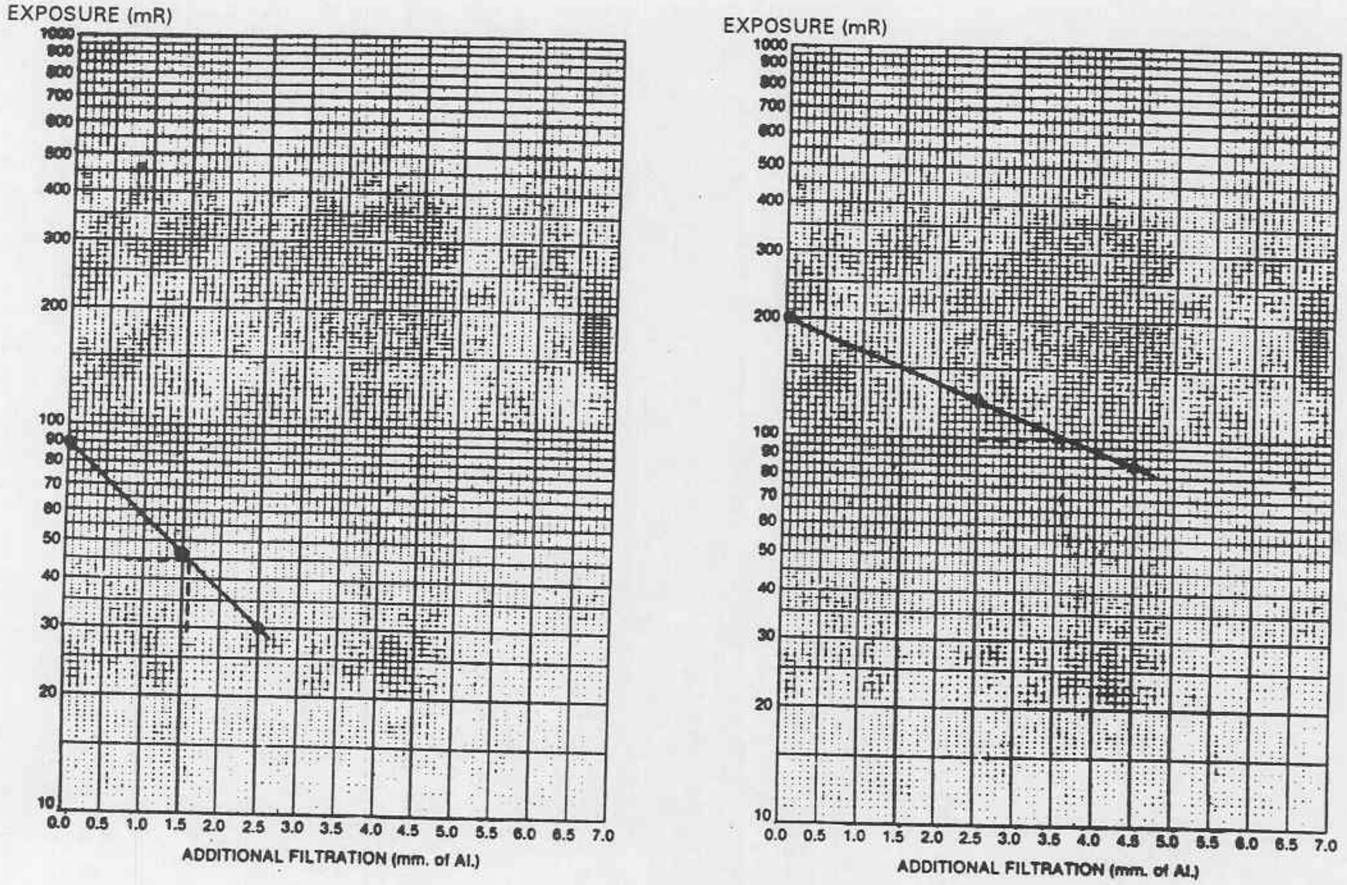
Verify that the half-value layer of the useful beam for a given X-ray tube potential is not less than the values shown in Table 6-1.

NEMA Standard 5-15-1979.

TABLE 6-4 HALF-VALUE LAYERS AS A FUNCTION OF FILTRATION AND TUBE POTENTIAL FOR DIAGNOSTIC UNITS*

Total Filtration mm Al	Peak Potential (kVp)									
	30	40	50	60	70	80	90	100	110	120
	Typical Half-Value Layers (mm Al)									
0.5	0.36†	0.47†	0.58	0.67	0.76	0.84	0.92	1.00	1.08	1.16
1.0	0.55	0.78	0.95	1.08	1.21	1.33	1.46	1.58	1.70	1.82
1.5	0.78	1.04	1.25†	1.42†	1.59†	1.75	1.90	2.08	2.25	2.42
2.0	0.92	1.22	1.49	1.70	1.90	2.10	2.28	2.48	2.70	2.90
2.5	1.02	1.38	1.69	1.95	2.16	2.37†‡	2.58†‡	2.82†‡	3.06†‡	3.30†‡
3.0	. . .	1.49	1.87	2.16	2.40	2.62	2.86	3.12	3.38	3.65
3.5	. . .	1.58	2.00	2.34	2.60	2.86	3.12	3.40	3.68	3.95

* For full-wave rectified potential.
† Recommended minimum HVL for radiographic units.
‡ Recommended minimum HVL for fluoroscopes.



EXAMPLE A

EXAMPLE B

BEAM QUALITY GRAPHING EXAMPLES

Figure 6-6
HALF-VALUE LAYER DETERMINATION GRAPHS

SECTION 7.0

NOT APPLICABLE FOR THIS MANUAL

NO TEXT

SECTION 8.0

APPENDIX

The following list is intended to help the installer determine mounting information only, and does not imply compatibility. See Section 1 for compatibility information.

MANUFACTURER	TUBE HOUSING	FOCAL SPOT TO PORT MOUNTING	DISTANCE TO COLLIMATOR MOUNTING FLANGE
Eureka	Emerald Series	2 1/16"	3/8" (.375)
	Diamond Series	2 1/16"	3/8" (.375)
	Sapphire Series	2 3/16"	1/4" (.250)
Eimac	B100	2 17/64"	11/64" (.171)
	B150	2 11/64"	17/64" (.265)
General Electric	Maxiray 100	2 5/16"	1/8" (.125)
	HRT, MX75	2 1/16"	3/8" (.375)
Picker/Dunlee	DU-140	2 1/16"	3/8" (.375)
	DU-200	2 1/16"	3/8" (.375)
	DU-300	2 9/32"	5/32" (.156)
	PX-400	2 5/16"	1/8" (.125)
Machlett	DX40 Series	2 1/16"	3/8" (.375)
	DX50 Series	2 3/16"	1/4" (.250)
	DX60 Series	2 5/16"	1/8" (.125)
	DX70 Series	2 5/16"	1/8" (.125)

TABLE 8-1
TUBE MOUNTING INFORMATION

TABLE 8-2

SIGNAL NAMES DEFINITION

SID	Source to Image Distance.
VSID	Voltage representing **SID**.
VCSID	Voltage representing Continuous **SID**.
SID TRUE	Signal representing the Operating SID Range.
XF	X-ray Field.
VXFC	Voltage at the Collimator Feedback Potentiometer Wiper representing the X-ray Field in the Cross Dimension.
VXFL	Voltage at the Collimator Feedback Potentiometer Wiper representing the X-ray Field in the Long Dimension.
IR	Image Receptor (Cassette Tray).
VIRC	Voltage from the Cassette Sensing Element representing the Image Receptor size in the Cross Dimension.
VIRL	Voltage from the Cassette Sensing Element representing the Image Receptor size in the Long Dimension.
IR TRUE	Voltage representing the Presence of a Cassette
VCPC	Voltage applied to the Collimator Potentiometer in the Cross Position.
VCPL	Voltage applied to the Collimator Potentiometer in the Long position.

TABLE 8-3
40 CONDUCTOR CABLE COLOR CROSS REFERENCE

OLD	NEW
Black	Black
Red	Red
White	White
Green	Green
Orange	Orange
Blue	Blue
Brown	Black/White
Yellow	Orange/Green
Violet	Blue/Red
Gray	Blue/Black
Pink	Orange/Red
Tan	Green/Black
Red/Green	Red/Green
Red/Yellow	Black/Red
Red/Black	Red/Black
White/Black	White/Black
White/Red	White/Red
White/Green	Green/White
White/Yellow	Orange/Black/Green
White/Blue	Blue/White
White/Brown	Blue/White/Orange
White/Orange	Orange/White/Blue
White/Gray	Orange/Black
White/Violet	Red/White
White/Black/Red	White/Black/Red
White/Black/Green	White/Black/Green
White/Black/Yellow	Black/Red/Green
White/Black/Blue	Blue/Black/White
White/Black/Brown	Green/Black/Orange
White/Black/Orange	Black/White/Orange
White/Black/Gray	Green/Black/White
White/Black/Violet	Orange/Black/White
White/Black/Black	Black/White/Red
White/Red/Black	Red/Black/White
White/Red/Red	White/Red/Orange
White/Red/Green	White/Red/Green
White/Red/Blue	White/Red/Blue
White/Red/Brown	Red/White/Green
White/Red/Violet	Red/Black/Green
White/Green/Black	Black/White/Green

(VIRC, IR, TRUE, VISID OUT, VSID IN and VIRL signals are analog and cannot be expressed in "Logic" terms)

SIGNALS (paragraph ref.)	3.2	3. 2.1	3. 2.2	3.3	3. 3.1	3. 3.2	3.4	3. 4.1	3. 4.2	3. 4.4	3. 4.6	3. 4.8	3.5	3. 5.2
VIRC (TS4-7), VIRL (TS4-5)														
$\overline{\text{STEREO/TOMO}}$ (TS4-11)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
$\overline{\text{C = 0°, T = 0°}}$ (TS3-10)	0	1	1	0	1	1	0	0	0	0	0	0	0	0
$\overline{\text{C = +90°}}$ (TS3-6)	1	0	1	1	0	1	1	1	1	1	1	1	1	1
$\overline{\text{C = −90°}}$ (TS3-7)	1	1	0	1	1	0	1	1	1	1	1	1	1	1
$\overline{\text{C = +90°, T = +90°}}$ (TS3-9)	1	1	1	1	0	1	1	1	1	1	1	1	1	1
$\overline{\text{C = −90°, T = −90°}}$ (TS3-8)	1	1	1	1	1	0	1	1	1	1	1	1	1	1
IR TRUE														
$\overline{\text{40" SID}}$ (TS4-14)	1	1	1	1	1	1	1	1	0	1	1	1	1	1
$\overline{\text{72" SID}}$ (TS4-9)	1	1	1	1	1	1	1	1	1	0	1	1	1	1
EXP. REL. RY (TS4-8)	0	0	0	0	0	0	0	1	0	0	0	0	0	1
$\overline{\text{TABLE LEFT SIDs}}$ (TS4-17)	1	1	1	1	0	1	1	1	1	1	1	1	1	1
$\overline{\text{TABLE RIGHT SIDs}}$ (TS4-15)	1	1	1	1	1	0	1	1	1	1	1	1	1	1
$\overline{\text{WALL L/R SIDs}}$ (TS4-19)	1	0	0	1	1	1	1	1	1	1	1	1	1	1
$\overline{\text{VERT SIDs}}$ (TS4-10)	0	1	1	0	1	1	0	0	0	0	0	0	0	0

TABLE 8-4
LINEAR II LOGIC CHART

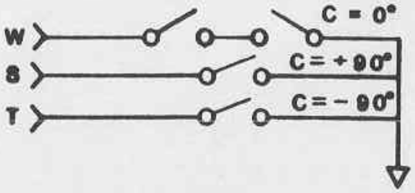
"X" – Don't Care

"1" – Logic High (+15 v)

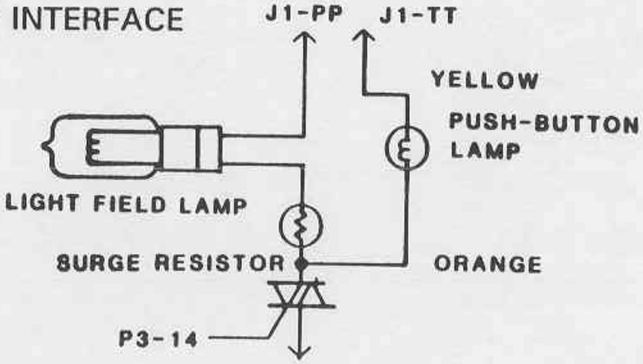
"0" – Logic Low (0 v)

P2	Ribbon Color	P3	Function
1	Brn		N/C
2	Red		N/C
3	Orn		Long. Pot. #1 & Cross Pot. #3 – GND
4	Yel		Long. Pot. #2 – VXFL
5	Grn		Caross Pot. #1 – VCPC
6	Blue		Cross Pot. #2 – VXFC
7	Vio		Long. Pot. #3 – VCPL
8	Gry	1	VCC +15 VDC
9	Wht	2	Long. Open
10	Blk	3	72" SID IND.
11	Brn	4	N/C
12	Red	5	N/C
13	Orn	6	Long. READ IND.
14	Yel	7	40" SID IND.
15	Grn	8	MANUAL IND.
16	Blue	9	CROSS READY IND.
17	Vio	10	Long. Close
18	Gry	11	EXP. HOLD IND.
19	Wht	12	CROSS CLOSE
20	Blk	13	CROSS OPEN

TABLE 8-5
TILTING WALL BUCKY INTERFACE


W
S
T
C = 0°
C = +90°
C = –90°

P-1
ELCO CONNECTOR


J1-PP
J1-TT
YELLOW
PUSH-BUTTON LAMP
LIGHT FIELD LAMP
SURGE RESISTOR
ORANGE
P3-14

P3	Ribbon Color	P2	PI	Function
1	Gry	8		
2	Wht	9		
3	Blk	10		
4	Brn	11		
5	Red	12		
6	Orn	13		
7	Yel	14		
8	Grn	15		
9	Blue	16		
10	Vio	17		
11	Gry	18		
12	Wht	19		
13	Blk	20		
14	Brn			TO TRIAC GATE
15	Red		JJ	+28 VDC
16	Orn			N/C
17	Yel			N/C
18	Grn		NN	OVAC
19	Blue		NN	OVAC
20	Vio			TO TIMER SWITCH
21	Gry			TO TIMER SWITCH
22	Wht			*MOTOR COM.
23	Blk			*LONG MOTOR – BLK
24	Brn			*LONG MOTOR – RED
25	Red			*CROSS MOTOR – RED
26	Orn			*CROSS MOTOR – BLK

TABLE 8-5 (continued)
TILTING WALL BUCKY INTERFACE

*LINEAR II ONLY

SEE 40 CONDUCTOR CABLE COLOR CROSS REF.

Power Board T/S Number	40 Cond. Cable Color	ELCO CONN	Ribbon Color	PI Pin	Function
3-7	Wht/Grn	T	△1 Brown	1	C = −90°; Tilt Switch
3-9	Red/Grn.	N	Red	2	C = +90°, T = +90°
3-6	Wht/Red	S	△2 Orange	3	C = +90°
4-11	White	C	Yellow	4	Stereo/Tomo
4-9	Violet	J	Green	5	72" H SID
3-10	Wht/Red/Brn.	BB	Blue	6	C = 0°, T = 0°
4-18	Wht/Red/Red	AA	Violet	7	IR TRUE
4-5	Green	D	Gray	8	VIRL
4-4	Red/Yellow Red/Black	P	△3 White Black	9 10	PWR GRD PWR GRD
		N/C	Brown	11	N/C
		N/C	Red	12	N/C
4-17	Wht/Blue	V	Orange	13	Table Left SID
4-14	Wht/Blk/Blue	DD	Yellow	14	40" H SID
4-16	Wht/Yellow	U	Green	15	Vert. SID
4-15	Wht/Violet	z	Blue	16	Table Right SID
4-3	Brown Yellow	H	△4 Violet Gray	17 18	Logic GND Logic GND
4-20	Black	A	White Black	19 20	+15 VDC +15 VDC
4-8	Wht/Blk/Yellow	CC	Brown	21	Exposure Relay
3-8	Blue	F	Red	22	C = 90°, T = 90°
4-19	Wht/Blk/Brn.	EE	Orange	23	Wall L/R SID
			* Yellow	24	* Push Test
3-4	Wht/Blk/Orange	FF	Green	25	V SID Out
4-7	Tan	M	Blue	26	VIRC
3-5	Wht/Brown	W	Black		C – 0°, Tilt Switch
3-2	Wht/Blk/Violet	JJ	Red		to P3-15- (+28 VDC)

NOTES: △1 This wire crimped with Red lead from Tilt Switch.

△2 This wire crimped with White lead from Tilt Switch.

△3 These two wires crimped together with Brown lead form Tilt Switch.

△4 These two wires crimped together with Violet wire to Test Switch. Only for LINEAR II.

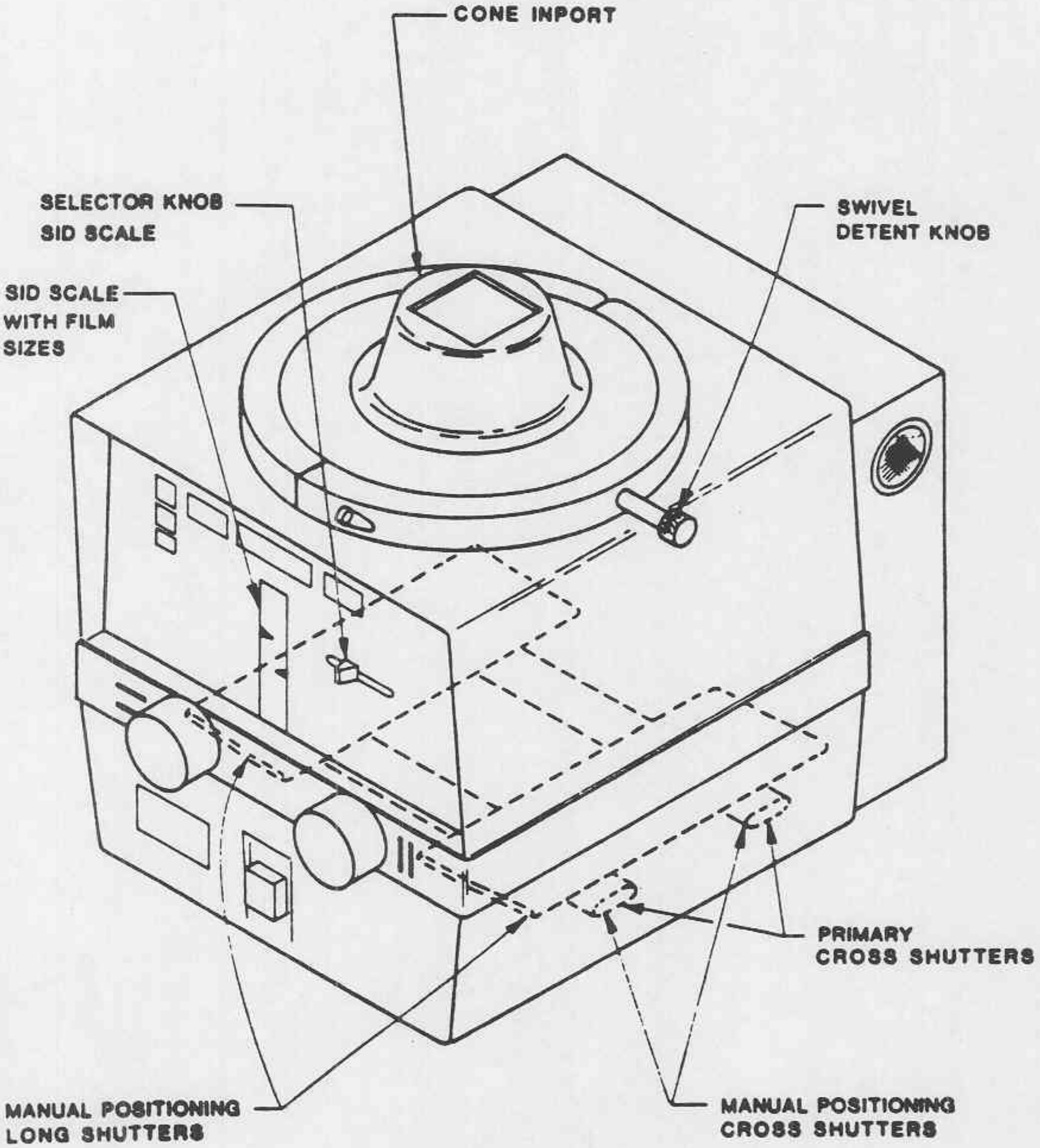
* LINEAR II ONLY

LINEAR I & II

TABLE 8-5 (continued)
TILTING WALL BUCKY INTERFACE

SECTION 9.0

THEORY OF OPERATION


CONE INPORT
SELECTOR KNOB
SID SCALE
SWIVEL
DETENT KNOB
SID SCALE
WITH FILM
SIZES
PRIMARY
CROSS SHUTTERS
MANUAL POSITIONING
LONG SHUTTERS
MANUAL POSITIONING
CROSS SHUTTERS

COLLIMATOR HEAD MECHANICAL VIEW

FIG. 9.1

9.0 THEORY OF OPERATION

9.1 Mechanical Operation

The Eureka Linear II Series Collimator contains two major sets of shutters, long and cross, which define the absolute x-ray field size. There is also a fixed lead cone which protrudes into the port of the x-ray tube to help reduce the effects of off-focus radiation.

Both shutter mechanisms are geared with anti-backlash mechanisms and coupled with shafts to knobs on the front panel. The shutters may be positioned manually with these knobs. A field size indicator scale indicates all conventional film sizes, and the scale is selected depending on the SID in use. A knob on the front panel is used to select the appropriate scale (see Fig. 9.1).

All Eureka Linear Series Collimators have a swivel mount configuration. Detents are located at 90 degree increments. By unscrewing the detent knob (see Fig. 9.1), the collimator may be oriented to any position for achieving proper x-ray field to cassette alignment for table top or non-bucky operation.

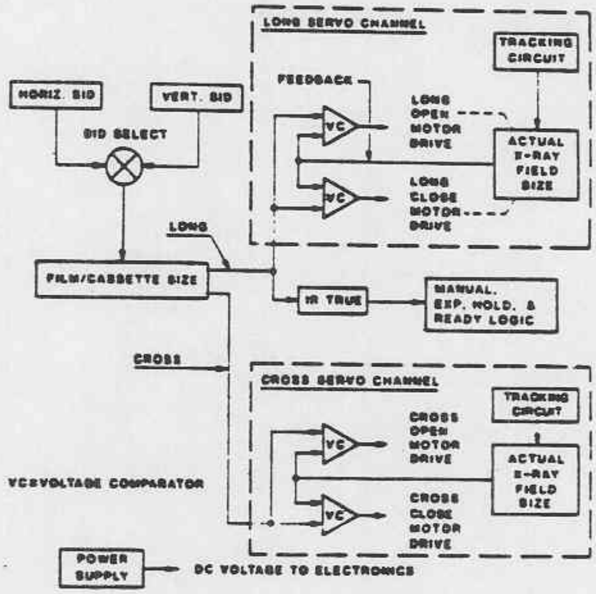
The shutter mechanism has been precisely aligned with respect to the mounting flange at the factory; therefore, the necessity for field alignment of central ray has been virtually eliminated.

9.2 Electronic Operation

The collimator electronics consists of the following systems and sub-systems:

- Long and Cross Servo Channels
- Vertical SID Voltage Range
- Exposure Hold and Ready Logic
- Manual Operation Logic
- Power Supply and Lamp Circuit

The operating system is represented by the following block diagram:


LONG SERVO CHANNEL
TRACKING CIRCUIT
HORIZ. SID
VERT. SID
SID SELECT
FEEDBACK
LONG OPEN MOTOR DRIVE
VC
ACTUAL X-RAY FIELD SIZE
VC
LONG CLOSE MOTOR DRIVE
LONG
FILM/CASSETTE SIZE
IR TRUE
MANUAL. EXP. HOLD. & READY LOGIC
CROSS
CROSS SERVO CHANNEL
TRACKING CIRCUIT
CROSS OPEN MOTOR DRIVE
VC
ACTUAL X-RAY FIELD SIZE
VC=VOLTAGE COMPARATOR
VC
CROSS CLOSE MOTOR DRIVE
POWER SUPPLY
DC VOLTAGE TO ELECTRONICS

NOTE: Refer to section 8 for definitions.

BLOCK DIAGRAM

Figure 9.2

9.2.1 Power Supplies – Schematic 70-08009

There are two power supplies for the collimator operation, a 27 volt A.C. supply protected by fuse F2 for the light field lamp and servo motors, and a low voltage, 15 volt D.C. regulated supply for the electronics.

The power transformer T1 is the source for both supplies with the 27 AC tap supplying the lamp and motors. The 19 VAC tap voltage is rectified by bridge B2 to an unregulated 28 VDC. This 28 VDC supplies the front panel lamps and VR1, a 3-terminal 15 volt 7815 IC voltage regulator. This supply is located on the master printed circuit board located in the power chassis (See Schematic 70-08009).

9.2.2 Light Field Lamp Circuit – Schematic 70-08032

The light-field lamp voltage is switched on and off by the 15 amp triac located on the lamp bracket. The gate signal is controlled by the output of IC4 (555 Timer) with an "ON" time of 25 seconds controlled by R18 and C7. The timer is triggered by the front panel "LAMP" push button switch. The output of IC4 drives the Opto-Isolator, IC8, which shorts bridge B1 to supply gate current to the triac. The surge resistor in series with the lamp filament offers high resistance at turn-on, reducing the in-rush current and greatly extending the lamp life.

9.2.3 Shutter Servo System – Schematic 70-08002

Both axis shutter systems are identical, so explanation will be limited to the cross axis circuitry.

A voltage is derived at the wiper of the cassette size sensing mechanism which contains two components:

(A) Cassette Size
(B) Source to Image Distance (SID)

This compound voltage (VIRC) is then applied to the two voltage comparators, IC16A & B. These two voltage comparators have their opposite inputs supplied with a voltage (VXFC) from the collimator feedback potentiometer. The logic chart follows:

Input Voltage – VIRC	<	=	>	**Feedback Voltage – VXFC**
		PIN 1		
IC16A, pin 2 (close)	1	0	0	IC16A, pin 3
		PIN 7		
IC16B, pin 5 (open)	0	0	1	IC16B, pin 6 Where 0 = 0 vdc and 1 = +15 vdc

NOTE: VIRC and VXFC are analog voltages and cannot be expressed in 1's or 0's.

IC9A, an R-S flip-flop, is positioned in line with the "close" drive signal from IC16A. Whenever the shutters are opened beyond allowable limits, SID is changed, table or collimator are tilted, or cassette is inserted, IC9A changes state which "sets" the Q output to a zero state. This zero is applied to the "AND" Gate, IC11B, pin 6, which inhibits the open drive signal from IC16B. This occurs only after the servo logic has been satisfied. It is reset by the action of IC16A output going low. This occurs on each servo cycle as the Logic must always be satisfied after a closing action of the blades.

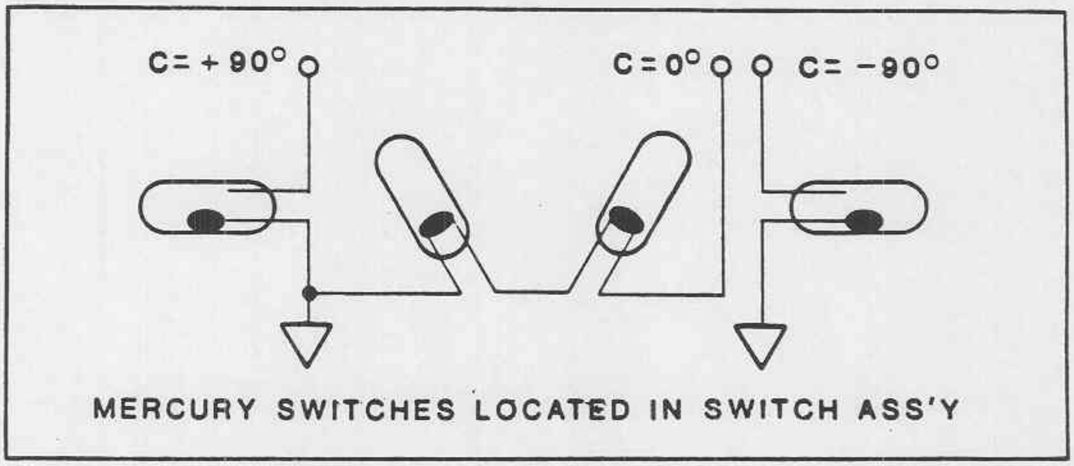
Assuming all system logic is satisfied (IC11B, IC10B, IC12B and IC17F), the appropriate "open" or "close" signal is applied to either IC5A (OPEN) or IC5B (CLOSE) driver. These drive IC1 or IC3 on the Motor Drive P.C.B. (Schematic 70-08032) to supply 24 VAC to the reversible motor. IC2 on the motor drive P.C.B. couples the phase-shifting capacitor, C2, only during actual motor drive operation. The removal of this capacitor with no power applied reduces the effort required to position the shutters manually. After the system achieves balance a "1" is applied to IC5G turning on the CROSS READY INDICATOR lamp. A similar action applies to the Long logic circuitry. When both Cross and Long have been balanced, "1"'s from IC17F and IC17C drive NAND gate IC10A, AND gate IC11A and IC5E to extinguish the HOLD indicator lamp and energize the Exposure Release Relay, RLY1.

After this, the shutters may be manually closed without the servo logic producing an "EXPOSURE HOLD" condition. The "close" portion of the servo channel is always active. Therefore, if the shutters are manually positioned larger than the film size sensed, the servo system motors will drive the shutters closed until balance is re-achieved.

If STEREO/TOMO operation is selected, a "0" signal at IC7A, pin 1 causes the MANUAL indicator lamp to be lit via IC's 7D, 6D, 17D, and 5D, and through AND gate IC11A, places the system in MANUAL mode and inhibits the EXPOSURE HOLD function.

9.2.4 Tilt Monitors – Schematic 70-08009

The collimator has an angulation sensing switch assembly mounted on the inner front housing panel. There are four (4) mercury switches in the following configuration:



TILT SWITCH FUNCTIONS

Figure 9.3

Where: C = +90° means collimator CW 90° from vertical (beam left)

C = −90° means collimator CCW 90° from vertical (beam right)

C = 0° means collimator in vertical position

The switches C = +90° and C = −90° actually activate 10° before the 90° positions. The two C = 0° switches activate at plus and minus 10° from the zero degree position.

It is these switch signals along with an identical table tilt monitor switch (if the collimator is installed with a tilting table) that selects the appropriate SID circuit to apply the voltage (VSID) to the cassette tray input (Image Receptor).

NOTE: If the collimator is positioned between +10° and +80°, or −10° and −80°, the collimator is placed into "Manual" operation. It is also this switch selects the appropriate Image Receptor, table or wall (RLY2), for cassette size sensing.

THE FOLLOWING TABLE SHOWS THE TILT MONITORS SID SELECTION MATRIX WHERE:

V = VERTICAL SID SELECTION
H(T) = HORIZONTAL SID, TABLE IMAGE RECEPTOR
H(W) = HORIZONTAL SID, WALL IMAGE RECEPTOR
M = MANUAL OPERATION

TILT TABLE ANGULATION	COLLIMATOR ANGULATION				
	C=-90° -90° TO -80°	-79° TO -11°	C=0° -10°,0° 10°	11° TO 79°	C=90° 80° TO 90°
T=-90° -90° TO -80°	H(T)	M	M	M	M
-79° TO -11°	M	M	M	M	M
T=0° -10°,0° 10°	H(W)	M	V	M	H(W)
+11° TO +79°	M	M	M	M	M
T=+90° +80° TO +90°	M	M	M	M	H(T)

*CAN BE H(W) WITH BEAM AT WALL

ONLY ONE RECEPTOR CAN BE SELECTED. THIS IS DETERMINED UPON INSTALLATION AND SWITCH SW2-5 (BUCKY RIGHT) or SW3-5 (BUCKY LEFT) IS SELECTED FOR THE APPROPRIATE INSTALLATION CONFIGURATION.

9.2.5 SID Voltages – Schematics 70-08002 & 70-08009

A voltage (VSID) representing the SID, either horizontal or vertical, is applied to the input of cassette size sensing potentiometers. The approximate values are as follows:

	HORIZONTAL				VERTICAL				
SID	36	40	48	72	36	40	48	64	72
VSID V.D.C.	7.57	7.02	5.92	4.36	7.57	7.02	5.75	4.71	4.36

The SID voltages are individually adjusted by the two potentiometers, R23 (40" SID) and R24 (72" SID). The wipers of the potentiometers are connected to the 4 section analog switch, SW1. The activation of the SID switches (external to collimator) are, by the nature of the installation, such that only one switch can be activated at a time. A typical selection would then be:

C = +90° (BEAM LEFTWALL)
T = 0°
SID = 40" HORIZONTAL

With the collimator at C = +90° the mercury tilt switch in the collimator head will supply a logic "0" (LED 1 "ON", Logic "0" = 0 VDC) to Inverter IC8B, pin 3 yielding a logic "1" (Logic "1" = +15VDC) on AND Gate IC6B, pin 6. The table vertical (T = 0) will supply a Logic "1" (LEDs 6 and 7 "OFF") to AND Gate 6C, pins 8 and 9, yielding a logic "1" input to AND Gate 6B, pin 5. The logic "1" output of 6B, pin 4, will yield a logic "0" output from Inverter 4A, pin 16 (WALL L/R SID SW). This causes, via P/J1-23 and TS4-19, pin 14 of the Buffered Inverter IC3 on the Master Board (Schematic 70-08009) to supply a logic "1", via TS1-22, to the external 40" horizontal SID switch. (The logic "0" on TS4-19, WALL L/R SID SW, also selects the wall bucky via RLY-2 on the Master Board (Schematic 70-08009). Closing the external 40" HORIZONTAL SID SWITCH puts a logic "1" on TS1-14 yielding a logic "0" output from the Inverter IC2, pin 14 on the Master Board. Via TS4-14 and P/J1-14 (40" SID) logic "0" will be applied to Inverter IC14A, pin 1.

Because the collimator is at +90° the mercury tilt switches, via P/J1-6 (C = 0°, T = 0°, LED 4 "OFF"), a logic "1" is applied to Inverter 14A, pin 1. The logic "1" output of 14A, pin 2 causes SW2 to select the 40" SID voltage, supplied by R23, to Buffer IC3A. The output of IC3A is supplied to the correct cassette tray input via P/J1-25, TS3-4 and TS3-14 (TABLE) or TS2-19 (WALL).

9.2.6 Exposure Hold and Manual Circuits – Schematic 70-08002

The collimator is placed into "MANUAL" operation upon the following conditions: (x-ray exposure is permitted)

A. When NO cassette is present

B. Collimator or table NOT at −90°, 0°, or +90°

C. An external signal for STEREO/TOMO operation is present

The collimator is placed into "EXPOSURE HOLD" when:

A. Cassette is present but servo system is NOT sized properly. This occurs during cycling of shutter blades.

B. If the collimator is NOT positioned at one of the permitted SIDs, i.e., 40" or 72" SID, and the cassette is present.

9.2.7 "Manual Operation" – Schematic 70-08002

The presence of a cassette is detected by current flow through the size sensing potentiometers upon activation of a series "cassette present" switch. The current flows from the cassette trays via TS3-15 or TS2-20, TS4-18 and P/J1-6 through VR1, a 1.22 volt zener diode. This VR1 voltage is compared to that of a forward-biased silicon diode, D2, by Voltage Comparator IC13A. The output of IC13A results in a level where "1" = NO CASSETTE PRESENT (LED-2 ON) and a "0" = CASSETTE PRESENT (LED-2 OFF) known as IR TRUE (Not Image Receptor True).

This condition, NO CASSETTE PRESENT, will cause the "MANUAL" indicator on the front panel to be illuminated through Logic IC6D, IC17D and IC5D. Through Logic IC11A, 11D and 5E the Exposure Release Relay, RLY-1, will be energized permitting an x-ray exposure.

Also, if either the collimator or table is angulated beyond the 10 degree angles of horizontal or vertical, the appropriate logic levels at P/J1 pins 22, 2, 3, 1 or 6 will be at Level "1" causing the logic of IC6A, 6C, 7A, 7B, 7D, 7C, 17D and 5D to again place the system into "Manual" operation. In addition, the exposure release relay will be energized permitting x-ray exposure.

The last condition for "Manual" operation occurs when an external signal is applied between TS1-1 (common) and one of the inputs, TS1-2, 3, 4 or 5 (Schematic 70-08009).

This is the "STEREO/TOMO" input and can be supplied with any of the following levels:

A. 5 volts AC or DC
B. 15 volts AC or DC
C. 24 volts AC or DC
D. 120 volts AC

The external voltage is applied through Bridge B1 to supply bias current to the photodiode of Opto-isolator IC1. The photo transistor of IC1 then biases Inverter IC2 providing a "Low" to P/J1-4. The logic through IC7A, 7D, 6D, 17D, and 5D provides for an overriding "Manual" operation.

9.2.8 "Exposure Hold" Operation

When a cassette is inserted, the servo electronics become unbalanced and may indicate EXPOSURE HOLD until the shutters are sized properly. Cassette insertion also triggers timer IC15, which is configured as a 0.5 second mono-stable multivibrator. The output (Pin 3) is applied through IC2C to IC10B, and 10C. These gates, through IC17F, 17C, 10A, 11A, 17D and 5E, place the system into EXPOSURE HOLD. The prime purpose is to assure that the cassette is fully and properly inserted before the electronic servo system begins to achieve balance.

At the end of the 0.5 second time delay, the servo motors will be driven until balance is achieved. During any operation of a motor, the EXPOSURE HOLD circuit is activated, preventing an x-ray exposure.

Another condition that results in an EXPOSURE HOLD condition is after the insertion of a cassette, the collimator is "NOT" at an authorized SID of 40" or 72" Horizontal or Vertical. The system is placed in EXPOSURE HOLD until an authorized SID is achieved.

9.2.9 Programming Switches

There are two switch packages, SW2 and 3, that provide either test input signals or collimator functional programming.

SW2-1, 2, 3, 4, & 5, and SW3-1, 2, 3, 4, & 5 can be switched ON to provide simulated input signals to aid in the initial alignment or for trouble-shooting. They function as follows:

SWITCH	INPUTS
SW2-1	**14" Cross**
SW2-2	**5" Cross**
SW2-3	**14" Long**
SW2-4	**5" Long**
SW2-5	**Bucky Right**
SW3-1	**Unused**
SW3-2	**40" Horizontal SID**
SW3-3	**72" Horizontal SID**
SW3-4	**IR Select**
SW3-5	**Bucky Left**

These switches must be in the OFF position for actual operation of the system.

SW2-5 and SW3-5 are programmed at the time of installation to provide the appropriate logic sensing for selection of the Wall Image Receptor (Bucky) inputs. SW3-5 is selected if the receptor is located at the left end of the x-ray table. Only one selection can be made for any given installation.

9.2.10 Tracking

The collimator must "track" the various input sizes as well as "track" a given input size versus SID.

The tracking of input sizes is achieved by adjusting the collimator feedback potentiometer at the shutters closed position, and then adjusting the voltage to the collimator potentiometer (VCPL and VCPC). This is a factory adjustment procedure which provides the operating range of the feedback voltages (VXFL and VXFC).

Since the actual collimator shutters operate at two different distances from the x-ray tube focal spot, they require different voltage and resistance settings. The Long axis is the reference axis while the Cross axis is the secondary axis.

Therefore, only R26, VCPC, should be field adjusted. This is adjusted to achieve "balance" in the Long to Cross dimensions.

Tracking a given size for horizontal operation is easily and absolutely accomplished by the individual adjustments of R23 and 24.

9.2.11 IR Selection

The electronics are configured to accept cassette size inputs from two different image receptors, normally, one in the x-ray table and one located on a wall within the x-ray room. Relay RLY-2 is energized when the collimator is tilted to the programmed direction (SW2-5, Bucky Right or SW3-5, Bucky Left) and the x-ray table is not not tilted, and the collimator is angulated toward the table, RLY-2 remains relaxed and the table receptor is selected just as the conditon of table at zero, collimator at zero.

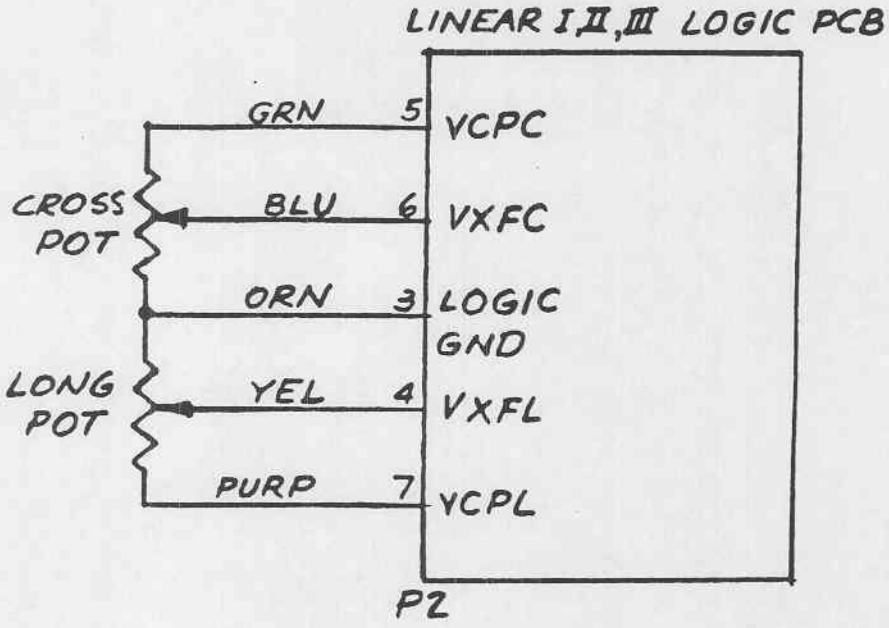
It is also this "Tilt" logic that determines the SID voltage selection through IC3 on the master board located in the power chassis. This permits independent SID positons for the wall receptor, table vertical, and table trendelenburg.

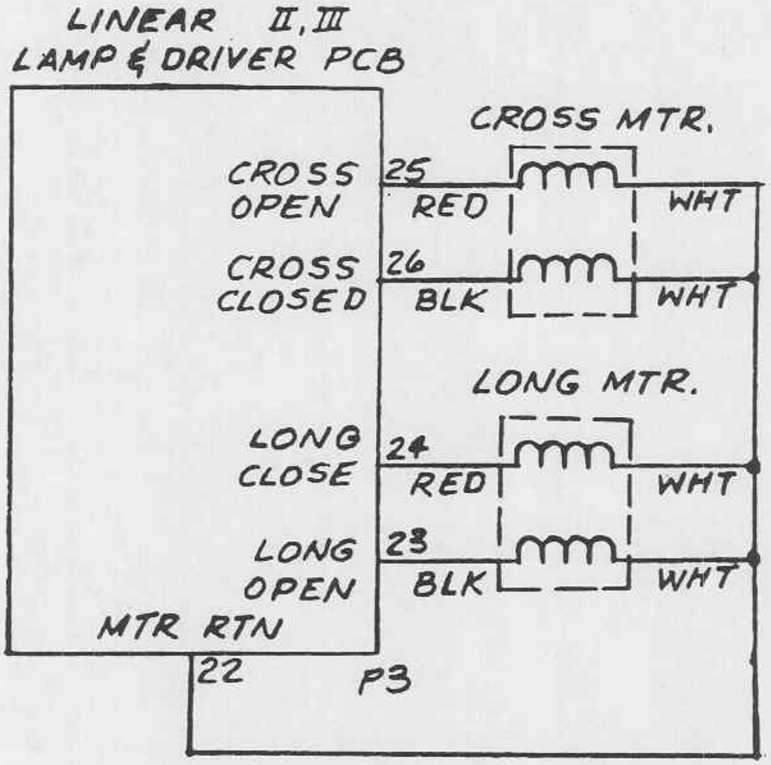
NO TEXT

SECTION 10.0

BILLS OF MATERIAL
AND
SCHEMATICS

NO TEXT


LINEAR I,II,III LOGIC PCB
GRN
5
VCPC
CROSS POT
BLU
6
VXFC
ORN
3
LOGIC GND
LONG POT
YEL
4
VXFL
PURP
7
VCPL
P2


LINEAR II,III LAMP & DRIVER PCB
CROSS MTR.
CROSS OPEN
25
RED
WHT
CROSS CLOSED
26
BLK
WHT
LONG MTR.
LONG CLOSE
24
RED
WHT
LONG OPEN
23
BLK
WHT
MTR RTN
22
P3

70-09038

Linear II

FEEDBACK POT & MOTOR WIRING

Figure 10.1

NO TEXT

BILL OF MATERIALS
LINEAR II LOGIC PCB ASSEMBLY
70-08080

Item No.	Ref. Design	Part No.	Description	Vendor Part No.
1		70-06251	Linear II Logic PCB	
2	IC1, 4, 5	70-03201	I.C., 16 Pin, Transistor Array	ULN2004A (XR2204)
3	IC2	70-03108	I.C., 14 Pin, Triple 3 Input NOR Gate	CD4025
4	IC3, 13	70-03351	I.C., 8 Pin, Dual OP-AMP	LM258 (2904)
5	IC6, 11, 12	70-03112	I.C., 14 Pin, Quad 2 Input And Gate	CD4081
6	IC7	70-03103	I.C., 14 Pin, Quad 2 Input Nand Gate	CD4011
7	IC8, 14, 17	70-03109	I.C., 14 Pin, Hex-Inverter	CD4069
8	IC9	70-03104	I.C., 14 Pin, Dual D Flip-Flop	CD4013
9	IC10	70-03107	I.C., 14 Pin, Triple 3 Input Nand Gate	CD4023
10	IC15	70-03353	I.C., 8 Pin, Timer	LM555
11	IC16, 18	70-03352	I.C., 8 Pin, Dual Voltage Comparator	LM393
12	SW1	70-03114	I.C., 14 Pin, Quad Bi-Lat. Switch	CD4066
13	C6	70-02501	Capacitor, Elect. 1mF, 50V	
14	C1-3, 18, 19, 21, 22	70-02506	Capacitor, Tant., 2.2mF @ 25V ±10%	
15	C24	70-02010	Capacitor, Mono., 0.1 uF @ 50V ±10%	
16	C4, 5, 7-10, 16, 20	70-02012	Capacitor, Mono., .001 mF @ 100V ±10%	
17	C11-15, 17, 23, 25-27	70-02030	Capacitor, Mono., .001 mF @ 200V ±10%	
18	D1, 2	70-03001	Diode	1N914
19	VR2	70-03021	Zener Diode, 4.7 VZ, 1/4W	1N750
20	LED 1, 2, 4-11	70-03061	LED (RED)	
21	LED 3	70-03062	LED (GREEN)	
22	VR1	70-03301	Ref. Diode 1.22 VZ	LM113
23	Q1, 2	70-03402	Transistor	2N2222
24	R2	70-00045	Resistor, Carb. Film, 1/4W, 1.5KΩ ±5%	
25	R3, 4, 9, 19, 20, 27-29	70-00064	Resistor, Carb. Film, 1/4W, 10KΩ ±5%	
26	R5	70-00058	Resistor, Carb. Film, 1/4W, 5.6KΩ ±5%	
27	R1	70-00079	Resistor, Carb. Film, 1/4W, 51KΩ ±5%	
28	R10	70-00091	Resistor, Carb. Film, 1/4W, 200KΩ ±5%	
29	R11	70-00057	Resistor, Carb. Film, 1/4W, 5.1KΩ ±5%	
30	R21	70-00061	Resistor, Carb. Film, 1/4W, 7.5KΩ ±5%	
31	R13, 30	70-00056	Resistor, Carb. Film, 1/4W, 4.7KΩ ±5%	
32	R17	70-00051	Resistor, Carb. Film, 1/4W, 3.0KΩ ±5%	
33	R22	70-00067	Resistor, Carb. Film, 1/4W, 15KΩ ±5%	
34	R7	70-00301	Resistor, Metal Film, 1/4W, 30.1Ω ±1%	RN55
35	R12	70-00302	Resistor, Metal Film, 1/4W, 137Ω ±1%	RN55
36	R6	70-00304	Resistor, Metal Film, 1/4W, 154Ω ±1%	RN55

LINEAR II LOGIC PCB ASSEMBLY
70-08080
Table 10.1

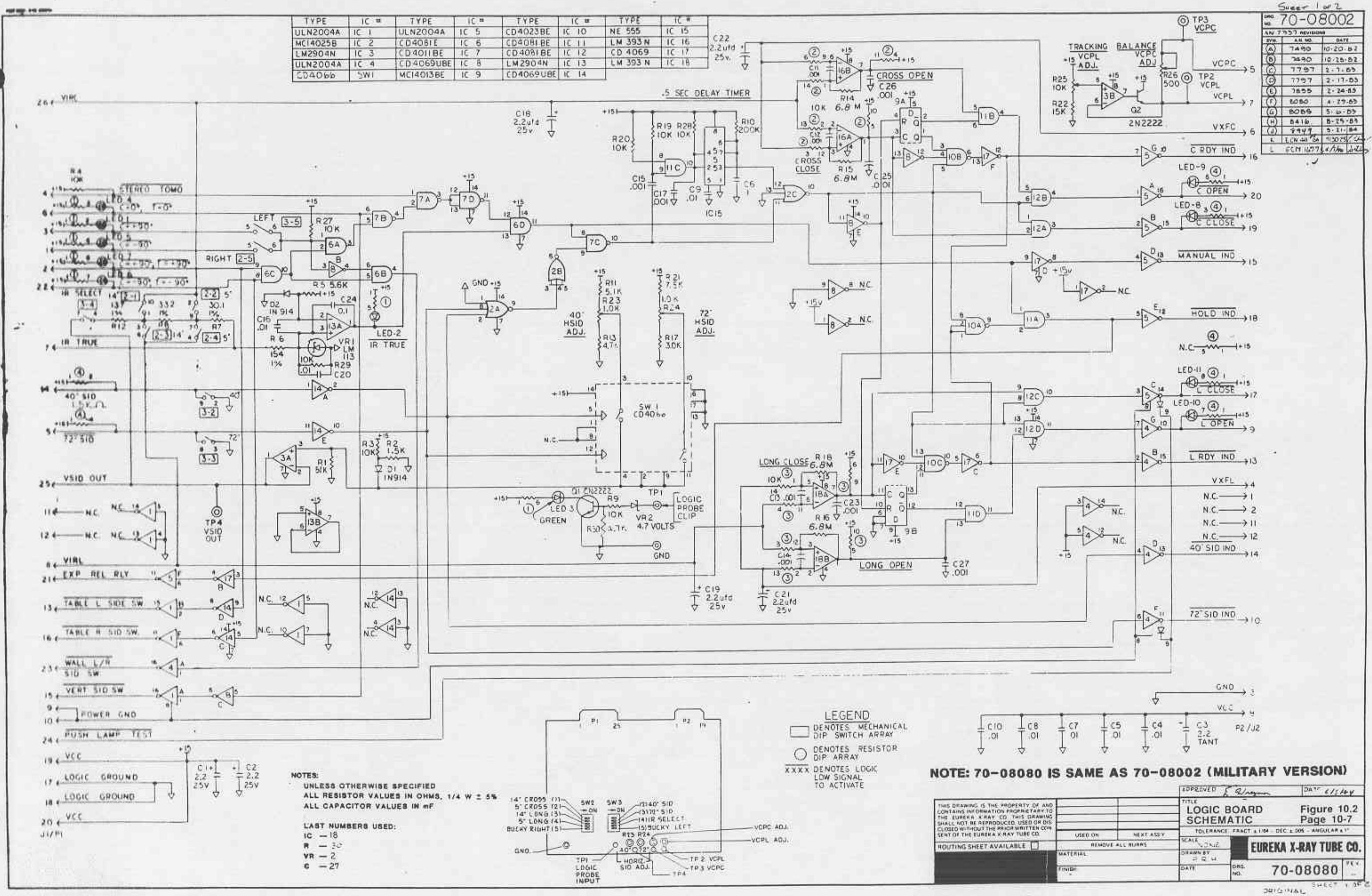
Item No.	Ref. Design	Part No.	Description	Vendor Part No.
37	R8	70-00307	Resistor, Metal Film, 1/4W, 332Ω ±1%	RN55
38	RP1, 4	70-00501	Resistor Pak, 8 Pin SIP, 1/4W, 680Ω	81-681
39	RP2, 3	70-00504	Resistor Pak, 14 Pin DIP, 1/4W, 10KΩ	141-103
40	R26	70-00603	Resistor, Trimmer, 4T, 500Ω	339P1-501
41	R25	70-00606	Resistor, Trimmer, 4T, 10KΩ	339P1-103
42	SW2, 3	70-04202	Switch, SPST DIP, 10 Pin	CTS206-5
43	TP1-4, GND	70-0624	Jumper, Bus Bar, 24 GA	
44	R23, 24	70-00604	Resistor, Trimmer, 4T, 1K	
45	R14-16, 18	70-00116	Resistor, Carb. Film, 1/4W, 6.8M ±5%	

LINEAR II LOGIC PCB ASSEMBLY
70-08080
Table 10.1 (Cont.)

Sheet 1 of 2

DWG. NO. 70-08002		
AN 7757 REVISIONS		
SYM.	A.N. NO.	DATE
Ⓐ	7490	10-20-82
Ⓑ	7490	10-25-82
Ⓒ	7797	2-7-83
Ⓓ	7797	2-17-83
Ⓔ	7855	2-24-83
Ⓕ	8080	4-27-83
Ⓖ	8066	5-6-83
Ⓗ	8416	8-25-83
Ⓙ	8947	5-31-84
K	ECN 411 5A	9/30/85
L	ECN 1677	4/1/86

TYPE	IC #	TYPE	IC #	TYPE	IC #	TYPE	IC #
ULN2004A	IC 1	ULN2004A	IC 5	CD4023BE	IC 10	NE 555	IC 15
MC14025B	IC 2	CD4081E	IC 6	CD4081BE	IC 11	LM 393 N	IC 16
LM2904N	IC 3	CD4011BE	IC 7	CD4081BE	IC 12	CD 4069	IC 17
ULN2004A	IC 4	CD4069UBE	IC 8	LM2904N	IC 13	LM 393 N	IC 18
CD4066	SW1	MC14013BE	IC 9	CD4069UBE	IC 14		


26 VIRC
4 STEREO TOMO
C-0°
L-0°
C+90°
L+90°
C-90°
L-90°
22 IR SELECT
7 IR TRUE
14 40° SID
5 72° SID
25 VSID OUT
11 N.C.
12 N.C.
8 VIRL
21 EXP REL RLY
13 TABLE L SIDE SW
16 TABLE R SID SW.
23 WALL L/R SID SW
15 VERT SID SW
9, 10 POWER GND
24 PUSH LAMP TEST
19 VCC
17 LOGIC GROUND
18 LOGIC GROUND
20 VCC
J1/P1
LEFT
RIGHT
LED-2 IR TRUE
.5 SEC DELAY TIMER
CROSS OPEN
CROSS CLOSE
LONG CLOSE
LONG OPEN
40° HSID ADJ.
72° HSID ADJ.
SW 1 CD4066
Q1 2N2222
LED 3
GREEN
VR2 4.7 VOLTS
LOGIC PROBE CLIP
TP1
TP4 VSID OUT
GND
TP3 VCPC
TRACKING VCPL ADJ.
BALANCE VCPC ADJ
TP2 VCPL
Q2 2N2222
VCPC 5
VCPL 7
VXFC 6
C RDY IND 16
LED-9
C OPEN 20
LED-8
C CLOSE 19
MANUAL IND 15
HOLD IND 18
LED-11
L CLOSE 17
LED-10
L OPEN 9
L RDY IND 13
VXFL 4
N.C. 1
N.C. 2
N.C. 11
N.C. 12
40° SID IND 14
72" SID IND 10
GND 3
VCC 4
P2/J2
C10 .01
C8 .01
C7 .01
C5 .01
C4 .01
C3 2.2 TANT
P1 1 25
P2 1 19
14" CROSS (1)
5" CROSS (2)
14" LONG (3)
5" LONG (4)
BUCKY RIGHT (5)
SW2 ON
SW3 ON
(2) 40" SID
(3) 72" SID
(4) IR SELECT
(5) BUCKY LEFT
R23 R24
40° 72°
VCPC ADJ.
VCPL ADJ.
GND.
TP1 LOGIC PROBE INPUT
HORIZ. SID ADJ.
TP 2 VCPL
TP 3 VCPC
TP4

NOTES:

UNLESS OTHERWISE SPECIFIED
ALL RESISTOR VALUES IN OHMS, 1/4 W ± 5%
ALL CAPACITOR VALUES IN mF

LAST NUMBERS USED:
IC — 18
R — 30
VR — 2
C — 27

LEGEND

▭ DENOTES MECHANICAL DIP SWITCH ARRAY

○ DENOTES RESISTOR DIP ARRAY

$\overline{\text{XXXX}}$ DENOTES LOGIC LOW SIGNAL TO ACTIVATE

NOTE: 70-08080 IS SAME AS 70-08002 (MILITARY VERSION)

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ROUTING SHEET AVAILABLE ☐

[redacted]

USED ON | NEXT ASSY

REMOVE ALL BURRS

MATERIAL

FINISH -

APPROVED E. Wagner DATE 6/5/84

TITLE LOGIC BOARD SCHEMATIC

Figure 10.2
Page 10-7

TOLERANCE: FRACT ± 1/64 - DEC ± .005 - ANGULAR ± 1°

SCALE NONE

DRAWN BY R.R.H.

DATE

EUREKA X-RAY TUBE CO.

DWG. NO. 70-08080 REV. —

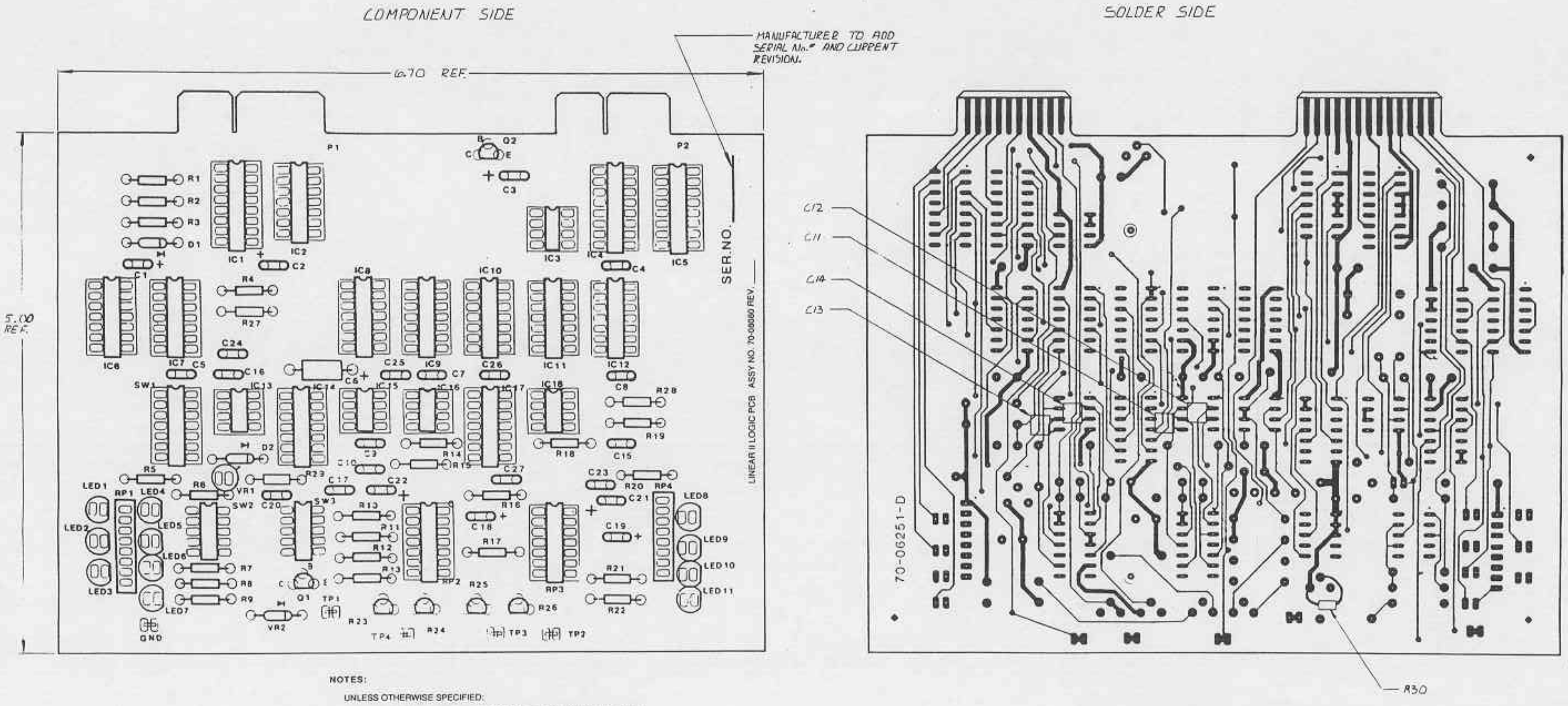
SHEET 1 OF 2

ORIGINAL

DWG. NO.	SC	REV
70-08002	2	L

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED



COMPONENT SIDE
SOLDER SIDE
MANUFACTURER TO ADD SERIAL No.# AND CURRENT REVISION.
6.70 REF.
5.00 REF.
P1
P2
Q2
C3
R1
R2
R3
D1
IC1
IC2
C1
C2
IC3
IC4
C4
IC5
R4
R27
IC8
IC10
C24
IC6
IC7
C5
C16
IC13
IC14
C6
C25
IC9
C7
IC15
IC16
C26
IC11
IC12
C8
R28
IC17
IC18
R19
SW1
D2
R14
R15
R18
C15
R5
R6
VR1
R23
C17
C22
C27
C23
R20
RP4
LED1
RP1
LED4
SW2
C20
SW3
R13
R16
C21
LED8
LED2
LED5
R11
C18
C19
LED9
LED6
R12
R17
R7
R8
R9
R10
Q1
TP1
RP2
R25
RP3
R21
LED10
LED3
LED7
VR2
R23
R24
R26
R22
LED11
GND
TP4
TP3
TP2
SER. NO.
LINEAR II LOGIC PCB ASSY NO. 70-08080 REV.
70-06251-D
C12
C11
C14
C13
R30

NOTES:

UNLESS OTHERWISE SPECIFIED:

1. ALL COLOR CODED RESISTORS TO BE INSERTED WITH TOLERANCE BAND TOWARD BOTTOM OR RIGHT HAND SIDE OF PCB.
2. ALL 1% RESISTORS TO BE INSERTED SO THAT RESISTANCE VALUE IS VISIBLE WHEN LOOKING DOWN @ THE PCB ON COMPONENT SIDE. ALSO, CAPACITORS DIODES ETC. MUST BE READ USING SAME METHOD.
3. APPLY CONFORMAL COAT BOTH SIDES WITH G.E. SR900 SILICONE. REFER TO INSTRUCTIONS FOR USE AND MATERIAL SAFETY DATA SHEET ON FILE WITH EUREKA FACILITIES DEPT.

NOTE: 70-08080 IS SAME AS 70-08002 (MILITARY VERSION)

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE
FRACTIONS DECIMALS ANGLES
.XX
.XXX

MATERIAL

FINISH

DO NOT SCALE DRAWING

ORIGINAL PRODUCT

APPROVALS	DATE
DRAWN DBA	10-1-86
CHECKED	
ISSUED	

EUREKA X-RAY TUBE CO.

LOGIC BOARD ASSEMBLY

Figure 10.3
Page 10-8

SIZE	ITEM CLASS	DWG. NO.	REV
D		70-08080	L

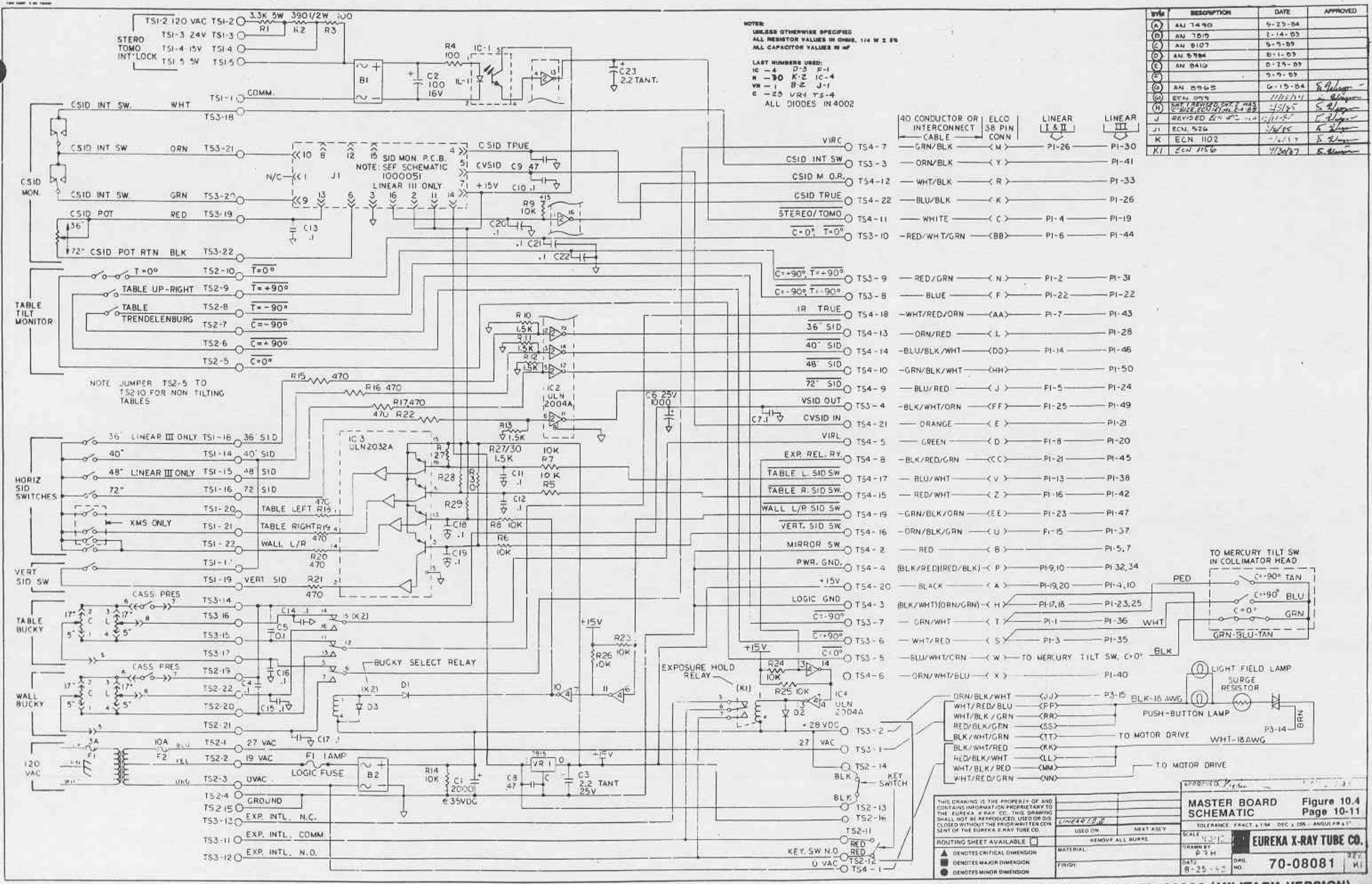
SCALE

SHEET 2 of 2

BILL OF MATERIALS
LINEAR II MASTER PCB ASSEMBLY
70-08081

Item No.	Ref. Design	Part No.	Description	Vendor Part No.
1		70-06257	Master PCB	
2	TS1-4	70-04521	Terminal Strip, 22 Pos.	
3		70-04003	Clip, Retaining	
4	K1, 2	70-04001	Relay, 24V, 4 Form C (4 P.D.T.)	
5	IC1	70-03041	I.C. 6 Pin DIP, Opto Coupler	MC2
6	IC2, 4	70-03201	I.C. 16 Pin DIP, Transistor Array	UNL 2004A
7	IC3	70-03202	I.C. 16 Pin DIP, Transistor Array	NL 2032A
8	VR1	70-03304	Voltage Reg. 15V	MC7815
9	B1, 2	70-03032	Bridge Rectifier, 6A	KBPC 104
10	K1, 2	70-04002	Socket, Relay	
11	C1	70-02505	Capacitor, Elect. 2,000mF, 35V	
12	C2	70-02503	Capacitor, Elect. 100mF, 16V	
13	C3, 23	70-02506	Capacitor, Tant. 2.2mF, 25V ±10%	
14	C6	70-02508	Capacitor, Elect. 1,000 mF, 25V	
15	C4, 5, 7, 10-22	70-02010	Capacitor, Ceram., 0.1mF, 50V	
16	D1, 2, 3	70-03012	Diode, 1 AMP, 200V	1N4002
17	R1	70-00401	Resistor, 5W, 3.3KΩ	
18	R2	70-00220	Resistor, 390Ω, 1/2W, ±5%	
19	R3, 4	70-00018	Resistor, 100Ω, 1/4W, ±5%	
20	R5-8, 14, 23-26	70-00064	Resistor, 10KΩ, 1/4W, ±5%	
21	R10-13, 27-30	70-00045	Resistor, 1.5KΩ, 1/4W, 1.5KΩ ±5%	
22	R15-22	70-00034	Resistor, 470Ω, 1/4W, ±5%	
23	C8, 9	70-02011	Capacitor, Ceram., 0.47mF, 50V	
24		70-10902	Screw, 6-32 x 0.25 Slotted Panhead	
25		70-10815	Nut, Hex, 6-32	
26		70-10726	Thermal Compound	
27		70-04635	Fuse Holder	
28	F1	70-04602	Fuse, 1 AMP	
29		70-04585	Heat Sink	
30		70-06602	Shrink Tubing 3/32" Dia.	

LINEAR II MASTER PCB ASSEMBLY
70-08081
Table 10.2


TS1-2 120 VAC TS1-2
TS1-3 24V TS1-3
TS1-4 15V TS1-4
TS1 5 5V TS1-5
STERO TOMO INT'LOCK
3.3K 5W R1
390 1/2W R2
100 R3
B1
C2 100 16V
R4 100
IC-1
IL-1
C23 2.2 TANT.
TS1-1 COMM.
CSID INT SW. WHT TS3-18
CSID INT SW ORN TS3-21
CSID INT SW. GRN TS3-20
CSID POT RED TS3-19
36"
72" CSID POT RTN BLK TS3-22
CSID MON.
C13 .1
SID MON. P.C.B. NOTE: SEE SCHEMATIC 1000051 LINEAR III ONLY
J1
N/C
C SID TRUE
CVSID C9 47
+15V C10 .1
R9 10K
C20 .1
C21 .1
C22 .1
T=0°
TABLE UP-RIGHT
TABLE TRENDELENBURG
TABLE TILT MONITOR
TS2-10 T=0°
TS2-9 T=+90°
TS2-8 T=-90°
TS2-7 C=-90°
TS2-6 C=+90°
TS2-5 C=0°
NOTE JUMPER TS2-5 TO TS2-10 FOR NON TILTING TABLES
R15 470
R16 470
R17 470
470 R22
R10 1.5K
R11 1.5K
R12 1.5K
IC2 ULN 2004A
R13 1.5K
C6 25V 1000
C7 .1
IC3 ULN2032A
R27/30 1.5K
R28
R29
R7 10K
R5 10K
C11 .1
C12 .1
C18 .1
C19 .1
R8 10K
R6 10K
36" LINEAR III ONLY TS1-18 36" SID
40" TS1-14 40" SID
48" LINEAR III ONLY TS1-15 48" SID
72" TS1-16 72" SID
TS1-20 TABLE LEFT R15 470
XMS ONLY
TS1-21 TABLE RIGHT R19 470
TS1-22 WALL L/R R20 470
HORIZ SID SWITCHES
TS1-17
VERT SID SW
TS1-19 VERT SID R21 470
CASS PRES
TABLE BUCKY
TS3-14
TS3-16
TS3-15
TS3-17
C14 .1
C5 0.1
(K2)
BUCKY SELECT RELAY
CASS PRES
WALL BUCKY
TS2-19
TS2-22
TS2-20
TS2-21
C4 .1
C16 .1
C15 .1
D1
D3
C17 .1
+15V
R23 10K
R26 10K
120 VAC
3A F1
10A F2
BLU
YEL
ORG
TS2-1 27 VAC
TS2-2 19 VAC
TS2-3 0VAC
F1 1AMP LOGIC FUSE
B2
R14 10K
C1 2000 35VDC
C8 47
7815 VR1
C3 2.2 TANT 25V
TS2-4 GROUND
TS2-15
TS3-13 EXP. INTL. N.C.
TS3-11 EXP. INTL. COMM
TS3-12 EXP. INTL. N.O.
EXPOSURE HOLD RELAY (K1)
R24 10K
R25 10K
IC4 ULN 2004A
D2
+15V
40 CONDUCTOR OR INTERCONNECT CABLE
ELCO 38 PIN CONN
LINEAR I & II
LINEAR III
VIRC TS4-7 GRN/BLK <M> P1-26 P1-30
CSID INT SW TS3-3 ORN/BLK <Y> P1-41
CSID M O.R. TS4-12 WHT/BLK <R> P1-33
CSID TRUE TS4-22 BLU/BLK <K> P1-26
STEREO/TOMO TS4-11 WHITE <C> P1-4 P1-19
C=0°, T=0° TS3-10 RED/WHT/GRN <BB> P1-6 P1-44
C=+90°, T=+90° TS3-9 RED/GRN <N> P1-2 P1-31
C=-90°, T=-90° TS3-8 BLUE <F> P1-22 P1-22
IR TRUE TS4-18 WHT/RED/ORN <AA> P1-7 P1-43
36" SID TS4-13 ORN/RED <L> P1-28
40" SID TS4-14 BLU/BLK/WHT <DD> P1-14 P1-46
48" SID TS4-10 GRN/BLK/WHT <HH> P1-50
72" SID TS4-9 BLU/RED <J> P1-5 P1-24
VSID OUT TS3-4 BLK/WHT/ORN <FF> P1-25 P1-49
CVSID IN TS4-21 ORANGE <E> P1-21
VIRL TS4-5 GREEN <D> P1-8 P1-20
EXP. REL. RY. TS4-8 BLK/RED/GRN <CC> P1-21 P1-45
TABLE L. SID SW TS4-17 BLU/WHT <V> P1-13 P1-38
TABLE R. SID SW. TS4-15 RED/WHT <Z> P1-16 P1-42
WALL L/R SID SW TS4-19 GRN/BLK/ORN <EE> P1-23 P1-47
VERT. SID SW. TS4-16 ORN/BLK/GRN <U> P1-15 P1-37
MIRROR SW. TS4-2 RED <B> P1-5,7
PWR. GND. TS4-4 (BLK/RED)(RED/BLK) <P> P1-9,10 P1 32,34
+15V TS4-20 BLACK <A> P1-19,20 P1-4,10
LOGIC GND TS4-3 (BLK/WHT)(ORN/GRN) <H> P1-17,18 P1-23,25
C=-90° TS3-7 GRN/WHT <T> P1-1 P1-36
C=+90° TS3-6 WHT/RED <S> P1-3 P1-35
C=0° TS3-5 BLU/WHT/GRN <W> TO MERCURY TILT SW. C=0°
TS4-6 ORN/WHT/BLU <X> P1-40
TO MERCURY TILT SW IN COLLIMATOR HEAD
RED
C=-90° TAN
C=+90° BLU
C=0°
GRN
WHT
BLK
GRN-BLU-TAN
ORN/BLK/WHT <JJ> P3-15
WHT/RED/BLU <PP>
WHT/BLK/GRN <RR>
RED/BLK/GRN <SS>
BLK/WHT/GRN <TT> TO MOTOR DRIVE
BLK/WHT/RED <KK>
RED/BLK/WHT <LL>
WHT/BLK/RED <MM>
WHT/RED/GRN <NN> TO MOTOR DRIVE
LIGHT FIELD LAMP
SURGE RESISTOR
BLK-18 AWG
PUSH-BUTTON LAMP
P3-14
BRN
WHT-18AWG
+28VDC TS3-2
27 VAC TS3-1
TS2-14
BLK
KEY SWITCH
BLK
TS2-13
TS2-16
TS2-11
RED
RED
KEY SW N.O. TS2-12
0 VAC TS4-1

NOTES:
UNLESS OTHERWISE SPECIFIED
ALL RESISTOR VALUES IN OHMS, 1/4 W ± 5%
ALL CAPACITOR VALUES IN uF

LAST NUMBERS USED:
IC —4 D-3 F-1
R —30 K-2 IC-4
VR —1 B-2 J-1
C —23 VR-1 TS-4
ALL DIODES IN 4002

SYM	DESCRIPTION	DATE	APPROVED
Ⓐ	AN 7490	5-23-84	
Ⓑ	AN 7819	2-14-83	
Ⓒ	AN 8107	5-5-83	
Ⓓ	AN 8394	8-1-83	
Ⓔ	AN 8416	8-25-83	
Ⓕ		9-9-83	
Ⓖ	AN 8965	6-15-84	[illegible]
(G1)	ECN 093	11/15/84	[illegible]
Ⓗ	SHT. 1 REVISED, SHT. 2 WAS "C" SIZE, ECN 121 [illegible]	[illegible]	[illegible]
J	REVISED ECN [illegible]	[illegible]	[illegible]
J1	ECN. 526	3/6/85	[illegible]
K	ECN 1102	[illegible]	[illegible]
K1	ECN 1156	4/30/87	[illegible]

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ROUTING SHEET AVAILABLE ☐

▲ DENOTES CRITICAL DIMENSION
■ DENOTES MAJOR DIMENSION
● DENOTES MINOR DIMENSION

LINEAR I & II
USED ON
NEXT ASS'Y
REMOVE ALL BURRS
MATERIAL:
FINISH:

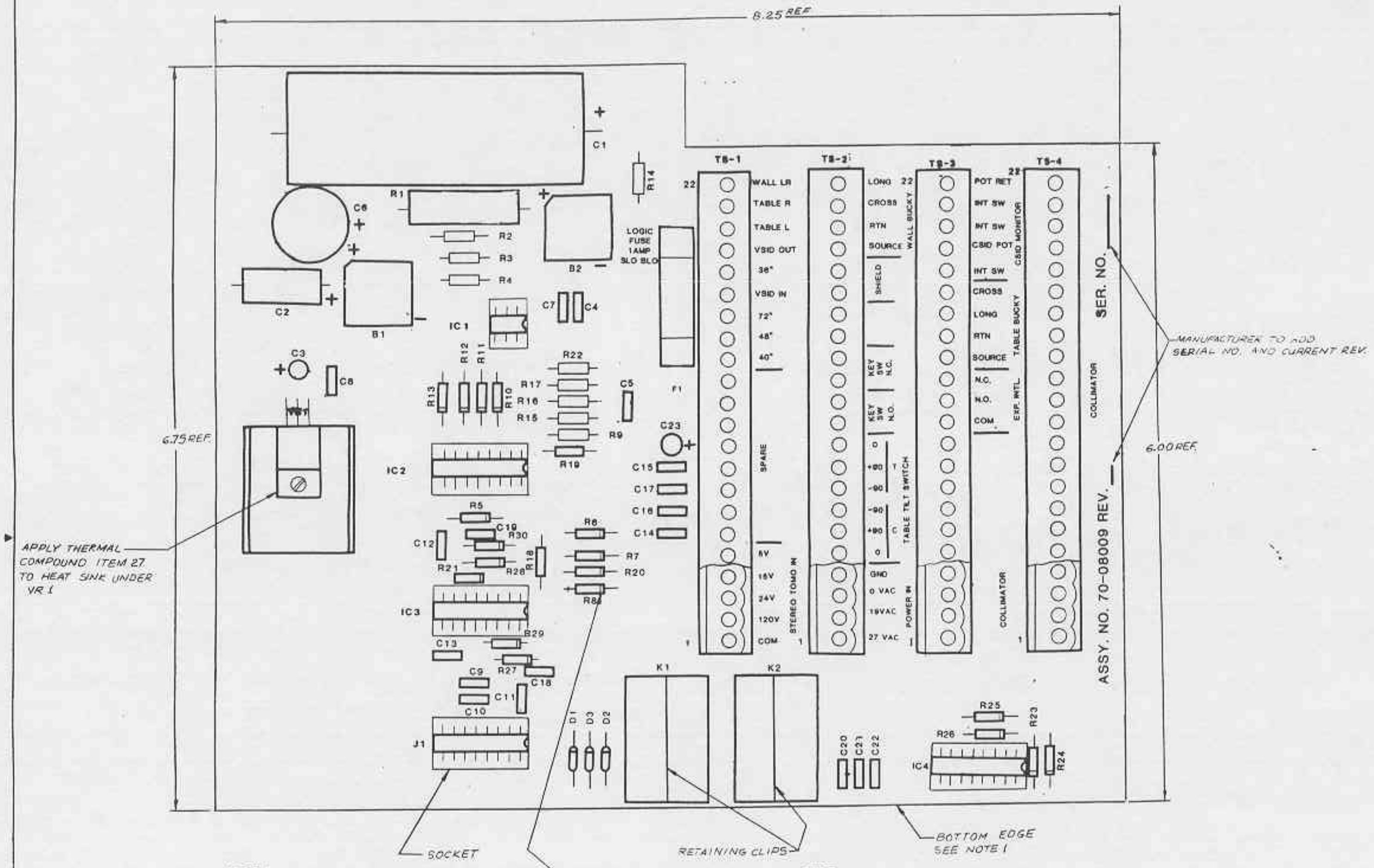
APPROVED
MASTER BOARD SCHEMATIC
Figure 10.4
Page 10-11
TOLERANCE: FRACT ± 1/64 DEC ± .005 ANGULAR ± 1°
SCALE NONE
DRAWN BY P R H
DATE 8-25-82
EUREKA X-RAY TUBE CO.
DWG NO. 70-08081
REV K1

NOTE: 70-08081 IS SAME AS 70-08009 (MILITARY VERSION)

DWG NO	SH	REV
70-08009	2	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED



8.25 REF
6.75 REF
6.00 REF
C1
R14
R1
C6
R2
R3
R4
B2
LOGIC FUSE 1AMP SLO BLO
C2
B1
C7
C4
IC1
R12
R11
R22
C3
C8
R13
R10
R17
R16
R15
C5
F1
R9
C23
IC2
R19
C15
C17
C16
C14
R5
C19
R30
R6
C12
R18
R7
R20
R21
R28
R8
IC3
R29
C13
R27
C9
C18
C11
C10
J1
D1
D3
D2
K1
K2
C20
C21
C22
R25
R26
R23
IC4
R24
TS-1
TS-2
TS-3
TS-4
22
WALL LR
TABLE R
TABLE L
VSID OUT
36"
VSID IN
72"
48"
40"
SPARE
5V
15V
24V
120V
COM
STEREO TOMO IN
1
LONG
CROSS
RTN
SOURCE
WALL BUCKY
SHIELD
KEY SW N.C.
KEY SW N.O.
0
+90
-90
-90
+90
0
T
C
TABLE TILT SWITCH
GND
0 VAC
19VAC
27 VAC
POWER IN
POT RET
INT SW
INT SW
CSID POT
CSID MONITOR
INT SW
CROSS
LONG
RTN
SOURCE
TABLE BUCKY
N.C.
N.O.
COM
EXP. INTL
COLLIMATOR
COLLIMATOR
SER. NO.
ASSY. NO. 70-08009 REV.
MANUFACTURER TO ADD SERIAL NO. AND CURRENT REV.
APPLY THERMAL COMPOUND ITEM 27 TO HEAT SINK UNDER VR 1
SOCKET
TOLERANCE BAND SEE NOTE 1
RETAINING CLIPS
BOTTOM EDGE SEE NOTE 1

NOTE :
PULL THE FOLLOWING NUMBERED PINS FROM EACH TERMINAL STRIP BEFORE SOLDERING: TS 1 PULL PIN 12; TS2 PULL PIN 18; TS 3 NONE; TS4 PULL PIN 6.

NOTES
UNLESS OTHERWISE SPECIFIED:

1. ALL COLOR CODED RESISTORS TO BE INSERTED WITH TOLERANCE BAND TOWARD BOTTOM OR RIGHT HAND SIDE OF PCB
2. ALL 1% RESISTORS TO BE INSERTED SO THAT RESISTANCE VALUE IS VISIBLE WHEN LOOKING DOWN ON COMPONENT SIDE OF PCB
3. ALL CAPACITORS, DIODES ETC TO BE INSERTED WITH VALUE AND/OR TYPE VISIBLE WHEN LOOKING DOWN ON COMPONENT SIDE OF PCB

NOTE: 70-08081 IS SAME AS 70-08009 (MILITARY VERSION)

[illegible]

DO NOT SCALE DRAWING

ORIGINAL PRODUCT

DRAWN M.LACH 9-11-87

[redacted]

MASTER BOARD ASSEMBLY

Figure 10.5
Page 10-12

SIZE D
ITEM CLASS AE
DWG NO 70-08081
REV 4
SCALE 1:2
SHEET 2 OF 2

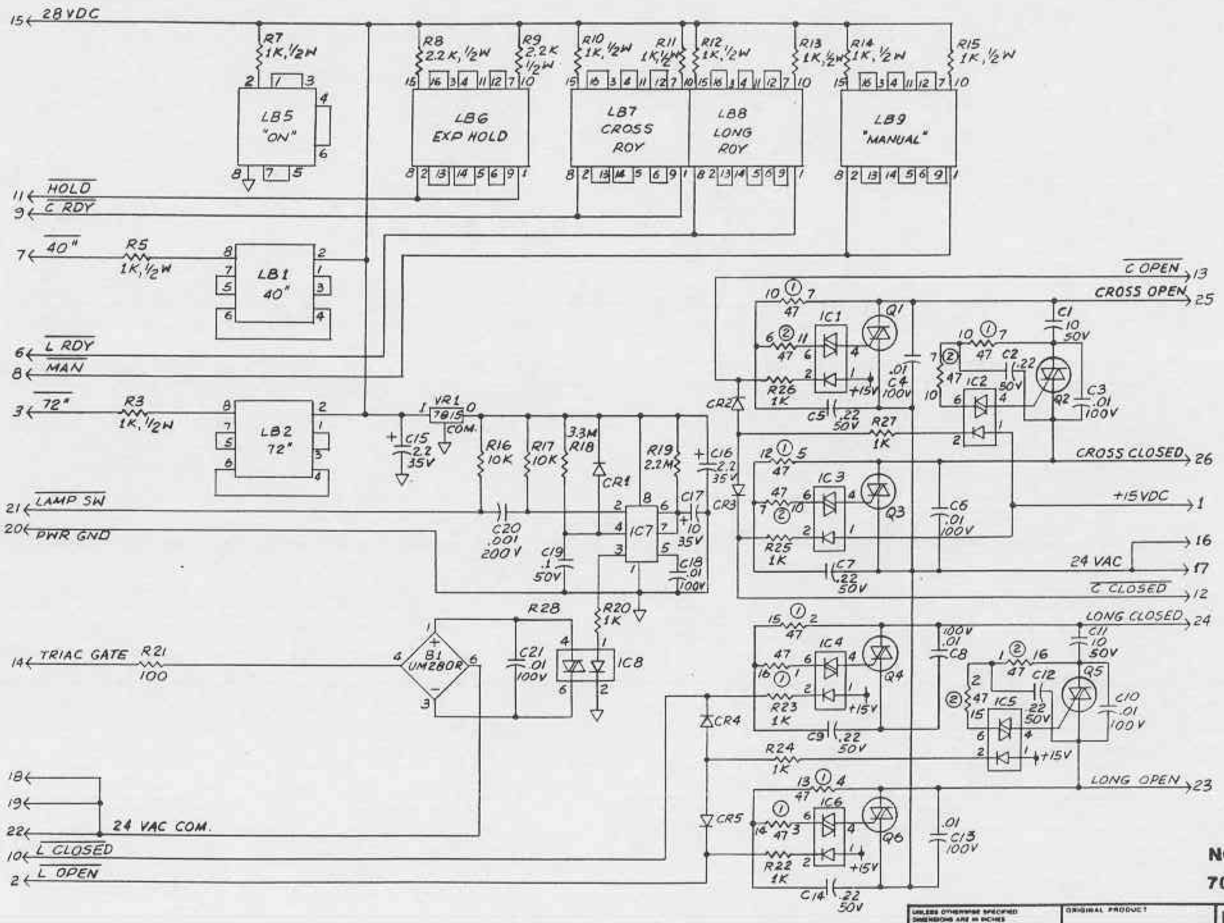
BILL OF MATERIALS
LINEAR II LAMP & DRIVER PCB ASSEMBLY
70-08082

Item No.	Ref. Design	Part No.	Description	Vendor Part No.
1		70-06269	Lamp & Driver PCB	
2	LB6	70-03065	LED Light Bar, 16 Pin DIP, H.E. Red	HLMP-2685D
3	LB1, 2, 5	70-03066	LED Light Bar, 8 Pin DIP, Yellow	HLMP-2755E
4	LB 7, 8	70-03067	LED Light Bar, 16 Pin DIP, Green	HLMP-2885E
5	LB 9	70-03063	LED Light Bar, 16 Pin DIP, Yellow	HLMP-2785
6	IC1-6, 8	70-03043	Opto Coupler/Isolator, 6 Pin DIP	MOC 3011
7	IC7	70-03353	I.C. 8 Pin DIP, Timer 555	
8	B1	70-03030	Bridge Rectifier, 1 AMP	VM28
9	Q1-6	70-03052	Triac	MAC97A5
10	C1-5	70-03012	Diode, 1 AMP, 200V	1N4002
11	RP1, 2	70-00508	Resistor Array, 16 Pin DIP, 47Ω	
12	LB1, 5, 6-9	70-04597	Socket, 16 Pin DIP, Wire Wrap	
13	LB2	70-04598	Socket, 8 Pin DIP, Wire Wrap	
14	C17	70-02511	Capacitor, Tant. 10 mF, 35V	
15	C15, 16	70-02509	Capacitor, Tant., 2.2 mF, 35V	
16	C1, 11	70-02101	Capacitor, Non-Pol, 10 mF, 50V	
17	VR1	70-03304	Voltage Regulator	MC7815
18	C19	70-02010	Capacitor, Ceramic, 0.1 mF, 50 VDC	
19	C3, 4, 6, 8, 10, 13, 18, 21	70-02012	Capacitor, Ceramic, 0.01 mF, 100 VDC	
20	C20	70-02030	Capacitor, Ceramic, 0.001 mF, 200 VDC	
21	C2, 5, 7, 9, 12, 14	70-02021	Capacitor, Ceramic, 0.22 mF, 50 VDC	
22	R20, 22-27	70-00042	Resistor, Carb. Film, 1/4W, 1KΩ ±5%	
23	R21	70-00018	Resistor, Carb. Film, 1/4W, 100Ω ±5%	
24	R19	70-00110	Resistor, Carb. Film, 1/4W, 2.2MΩ ±5%	
25	R18	70-00112	Resistor, Carb. Film, 1/4W, 3.3MΩ ±5%	
26	R3, 5, 7, 10-15	70-00225	Resistor, Carb. Film, 1/2W, 1KΩ ±5%	
27	R8, 9	70-00229	Resistor, Carb. Film, 1/2W, 2.2KΩ ±5%	
28	R28	70-06524	Jumper, Bus Bar, 24 AWG	Belden 8022
29	R16, 17	70-00064	Resistor, Carb. Film, 1/4W, 10KΩ ±5%	
30		70-04674	Spacer (.5" Long)	

LINEAR II, LAMP & DRIVER PCB ASSEMBLY
70-08082
Table 10.3

NOTES:
UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE 1/4 WATT THE VALUES ARE IN OHMS ±5%
ALL CAPACITOR VALUES ARE IN MICRO FARADS

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
	A	ORIGINATE PER ECN 1003	1/12/87	S. [illegible]
B-3	B	CHGED R28 PER ECN 1161	10/1/87	S. [illegible]



15 28VDC
R7 1K,½W
LB5 "ON"
R8 2.2K,½W
R9 2.2K ½W
LB6 EXP HOLD
R10 1K,½W
R11 1K,½W
R12 1K,½W
LB7 CROSS RDY
LB8 LONG RDY
R13 1K,½W
R14 1K,½W
R15 1K,½W
LB9 "MANUAL"
11 HOLD
9 C RDY
7 40"
R5 1K,½W
LB1 40"
6 L RDY
8 MAN
3 72"
R3 1K,½W
LB2 72"
VR1 7815 COM.
C15 2.2 35V
R16 10K
R17 10K
R18 3.3M
CR1
R19 2.2M
C16 2.2 35V
C17 10 35V
CR3
21 LAMP SW
20 PWR GND
C20 .001 200V
C19 .1 50V
IC7
C18 .01 100V
R28
R20 1K
14 TRIAC GATE
R21 100
B1 UM280R
C21 .01 100V
IC8
18
19
22
24 VAC COM.
10 L CLOSED
2 L OPEN
C OPEN 13
CROSS OPEN 25
IC1
Q1
C1 10 50V
C2 .22 50V
IC2
Q2
C3 .01 100V
C4 .01 100V
R26 1K
C5 .22 50V
R27 1K
CR2
CROSS CLOSED 26
IC3
Q3
C6 .01 100V
+15VDC 1
R25 1K
C7 .22 50V
16
24 VAC 17
C CLOSED 12
LONG CLOSED 24
IC4
Q4
C8 .01 100V
C11 10 50V
C12 .22 50V
IC5
Q5
C10 .01 100V
R23 1K
C9 .22 50V
CR4
R24 1K
LONG OPEN 23
IC6
Q6
C13 .01 100V
CR5
R22 1K
C14 .22 50V
+15V
47

NOTE: 70-08082 IS SAME AS 70-08052 (MILITARY VERSION)

DWG. NO. 70-08052
SH 1
REV B

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±
MATERIAL
FINISH
DO NOT SCALE DRAWING

ORIGINAL PRODUCT LINEAR II COLLIMAT.

APPROVALS	DATE
DRAWN M.LACH	3-19-86
CHECKED [illegible]	
ISSUED	

EUREKA X-RAY TUBE CO.

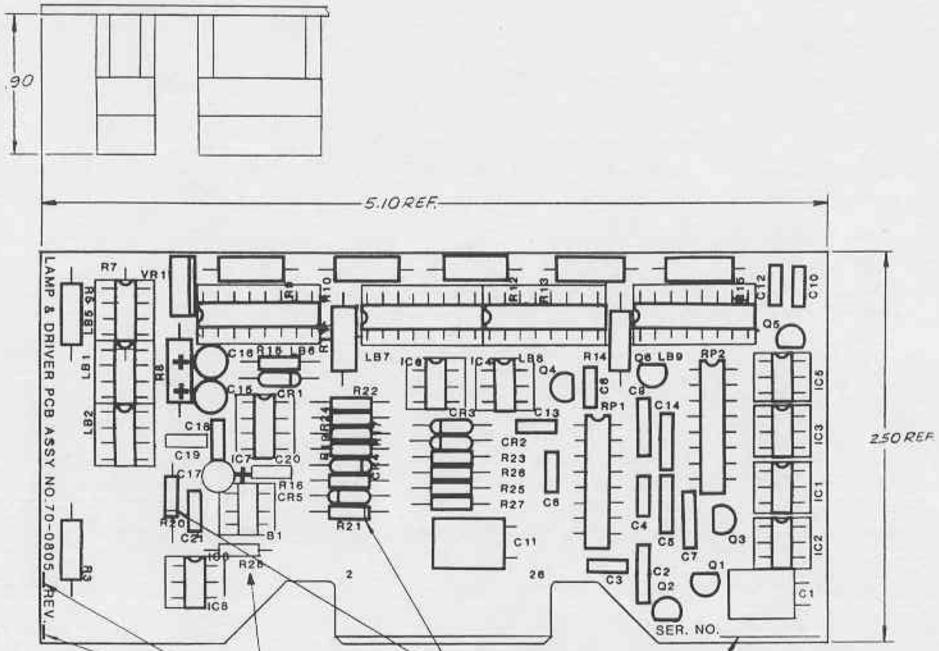
LAMP & DRIVER BOARD SCHEMATIC
Figure 10.6
Page 10-15

SIZE C
ITEM CLASS AE
DWG. NO. 70-08082
REV. B
SCALE —
SHEET 1 OF 2

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

NOTES
UNLESS OTHERWISE SPECIFIED':

1. ALL COLOR CODED RESISTORS TO BE INSERTED WITH TOLERANCE BAND TOWARD BOTTOM OR RIGHT HAND SIDE OF PCB
2. ALL CAPACITORS,DIODES ETC. TO BE INSERTED WITH VALUE AND/OR TYPE VISIBLE WHEN LOOKING DOWN ON COMPONENT SIDE OF PCB.
3. INSERT 24 AWG JUMPER WIRE, PT. # 70-06524, IN LOCATION FORMERLY OCCUPIED BY R28.


.90
5.10 REF.
2.50 REF.
LAMP & DRIVER PCB ASSY NO. 70-0805_ REV._
R7
VR1
R5
LB5
LB1
LB2
R8
R3
C16
R15
LB6
C15
CR1
C18
C19
C17
IC7
C20
R16
CR5
R20
C21
IC6
R28
B1
IC8
R22
R24
R21
R9
R10
R11
LB7
IC6
IC4
LB8
Q4
CR3
CR2
R23
R26
R25
R27
C13
C8
C11
R12
R13
R14
C5
Q6
LB9
RP2
C9
RP1
C14
C4
C6
C7
C3
C2
Q2
Q1
Q3
R15
C12
C10
Q5
IC5
IC3
IC1
IC2
C1
2
26
SER. NO.

SEE NOTE 3

TOLERANCE BAND SEE NOTE 1

MANUFACTURER TO ADD PART NO. DIGIT, CURRENT REVISION AND SERIAL NUMBER

DWG NO 70-08052 SH 2 REV B

NOTE: 70-08082 IS SAME AS 70-08052 (MILITARY VERSION)

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE
FRACTIONS DECIMALS ANGLES
MATERIAL
FINISH
DO NOT SCALE DRAWING

ORIGINAL PRODUCT COLLIMATOR

APPROVALS		DATE
DRAWN	M. LACH	5-2-86
CHECKED		
ISSUED		

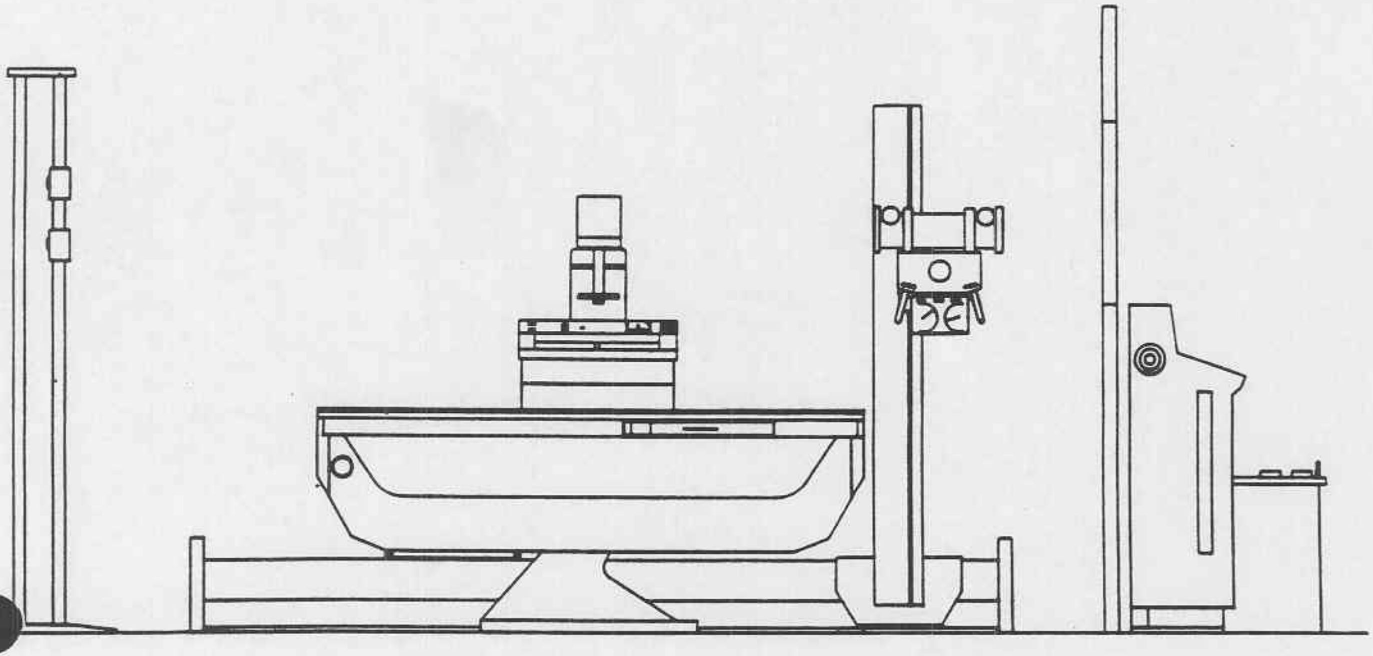
EUREKA X-RAY TUBE CO.

LAMP & DRIVER BOARD ASSEMBLY
Figure 10.7
Page 10-16

SIZE C
ITEM CLASS AE
DWG NO 70-08082
REV B
SCALE 2=1
SHEET 2 OF 2

CHAPTER 13

AUTOMATIC EXPOSURE CONTROL



Expos-AID AUTOMATIC EXPOSURE CONTROL
MODEL A3365-G

TABLE OF CONTENTS

1.0 INTRODUCTION 1-1

2.0 OPERATING INSTRUCTIONS 2-1
  2.1 Operating Conditions 2-1
  2.2 Operator Controls 2-2

3.0 SPECIFICATIONS 3-1
  3.1 System Performance 3-1
  3.2 Ion Chamber 3-2
  3.3 Controls and Displays 3-2
  3.4 Interface Requirements 3-3
  3.5 Power Consumption 3-3
  3.6 Physical Parameters 3-3
  3.7 Scheduled Maintenance 3-4
  3.8 Regulatory Compliance 3-4

4.0 INSTALLATION INSTRUCTIONS 4-1
Omitted for factory installed units

5.0 FIELD CALIBRATION INSTRUCTIONS 5-1
  5.1 Preliminary Steps 5-2
  5.2 Caution 5-2
  5.3 kVp Level Adjustment 5-5
  5.4 Chamber Gain (Main Density) Adjustment . . . 5-5
  5.5 Field Matching 5-6
  5.6 kVp Compensation 5-7
  5.7 Conclusion of Field Calibration 5-8

6.0 PRINCIPLES OF OPERATION 6-1
  6.1 Basic System Blocks 6-1
  6.2 Diagnostic/Troubleshooting Guide 6-3
  6.3 Factory Calibration Instructions 6-8

7.0 DOCUMENTATION

  7.1 Schematic Diagrams 7-1
  7.2 Component Location Diagrams 7-9
  7.3 Replacement Parts Lists 7-18

ADVANCED INSTRUMENT DEVELOPMENT, INC.
1011 N. 25TH AVENUE
MELROSE PARK, ILLINOIS 60160
Phone (708) 343-7777
FAX (708) 343-7795

18 October 1990

LIST OF FIGURES

Figure 2.1 Operator Controls 2-3
Figure 5.1 Adjustment Component Locations 5-3
Figure 5.2 Preamplifier Adjustment Component Locations . . . 5-4
Figure 6.1 Basic System Blocks 6-2
Figure 6.2 Factory Adjustment Component Locations 6-9
Figure 6.3 Multiplier Gain Adjustment 6-14
Figure 6.4 Preamplifier Adjustment Component Locations . . . 6-17
Figure 6.5 Preamplifier Adjustment Component Locations . . . 6-17

Schematic Diagrams

Figure 7.1 S60899B Input Amplifier Board 7-1
Figure 7.2 S60900F Logic Control Board 7-2
Figure 7.3 S60907D kVp Computer Board 7-3
Figure 7.4 S60916C Power Supply Board 7-4
Figure 7.5 S61017C Display Board 7-5
Figure 7.6 WA3365A Interconnection Drawing 7-6
Figure 7.7 S60917C Three Field Preamplifier 7-7
Figure 7.8 S60940D Single Field Preamplifier 7-8

Component Location Diagrams

Figure 7.9 60899B Input Amplifier Board 7-9
Figure 7.10 60900F Logic Control Board 7-10
Figure 7.11 60907D kVp Computer Board 7-11
Figure 7.12 60916C Power Supply Board 7-12
Figure 7.13 60917C Three Field Preamplifier 7-13
Figure 7.14 60940D Single Field Preamplifier 7-14
Figure 7.15 61017C Internal Display Board 7-15
Figure 7.16 60932C Top Bus Board 7-16
Figure 7.17 60905D Bottom Bus Board 7-16
Figure 7.18 61061A Display Connector Board 7-16
Figure 7.19 74047A Expos-AID A3365 Assembly 7-17

LIST OF TABLES

Table 5.1 kVp Compensation Settings 5-7
Table 7.1 Parts List 60899B Input Amplifier Board 7-18
Table 7.2 Parts List 60900F Logic Control Board 7-19
Table 7.3 Parts List 60907D kVp Computer Board 7-20
Table 7.4 Parts List 60916C Power Supply Board 7-23
Table 7.5 Parts List 61017C Display Board A3365-G 7-25
Table 7.6 Parts List 60917C Pre-Amp, Three Field Ionization Chamber 7-27
Table 7.7 Parts List 60940D Pre-Amp, Single Field Ionization Chamber 7-29

1.0 INTRODUCTION

The Expos-AID Automatic Exposure Control (AEC) greatly simplifies radiography by controlling the exposure required for every radiograph regardless of variations in parameters such as:

-- Patient anatomy and size.

-- Source-to-image distance (SID).

-- kVp-dependent response of screen-film combinations.

The operator is required only to select a reasonable kVp for the anatomy involved and select a field or combination of fields in line with the anatomy of principle interest. The Expos-AID AEC does the rest, automatically determining the exposure time for the precise milliampere-seconds (mAs) required to give excellent diagnostic radiographs. The results are:

-- Reduction in number of X-ray retakes, along with their cost and inconvenience.

-- Reduction in patient and operator radiation required to produce good films.

-- Films that are not only consistently diagnostic, but that are exposed consistently by all operators, on all AEC equipped generators, and on all shifts.

Some of the detailed features of the Expos-AID AEC are:

-- Switch adjustment for film density variations over approximately a ±50% range to suit individual preferences for darker or lighter films.

-- Automatically selects the proper ion chamber for the x-ray tube in use.

-- Post-exposure display (internal) of actual mAs (milliampere-seconds) allowing precise and rapid calibration of the AEC.

-- Exposure termination indicators (internal) to indicate proper termination by AEC or termination by backup timer or maximum mAs limit (fault condition).

-- Automatically inhibits exposure if an ion chamber field is not selected or if a fault condition exists.

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2.0 OPERATING INSTRUCTIONS

1. Turn on the x-ray generator.
2. Turn on the Expos-AID AEC.
3. Select the ion chamber field(s) appropriate for the anatomy involved.
4. Position the patient in front of the ion chamber, aligning the anatomy of interest with the selected ion chamber field(s).
5. Select an appropriate SID for the procedure, align the tube head and collimate properly.
6. Position the film cassette.
7. Select a reasonable kVp for the anatomy involved.
8. Select a backup mAs setting that will not interfere with AEC operation.
9. Make the exposure. The Expos-AID AEC will terminate the exposure when the film has been exposed to the proper Optical Density.

2.1 Operating Conditions

The Expos-AID AEC system is remarkably easy to use. Simply select a reasonable kVp for the anatomy involved. Position the patient in front of the film cassette and ion chamber detector aligning the anatomy of principle interest with one or more of the ion chamber fields. Activate only those fields behind the section to be examined by using the field selection buttons on the generator console.

For example, when shooting a normal chest in the anterior-posterior projection, select the ion-chamber fields behind the lungs. Or, when shooting a lateral skull align the skull with an ion chamber field. Or, to follow the course of pneumonia in the left lung with a series of radiographs, always align the ion-chamber field with the fluid in that particular lung being careful to activate only the field behind the left lung.

Do not align the ion-chamber field with anatomy other than that of principle interest. For example, do not align with the spine to see the lung and do not align with the lung to see the spine as this would obviously not produce the optimum exposures.

2.2 Operator Controls (Refer to Figure 2.1)

FIELD SELECTION (Located on generator console).

Three field ion chambers allow the selection of one or more fields to allow easy alignment of a detector with the area to be studied. Select only the fields aligned with areas of principle interest by depressing one or more of the field select buttons. Turn off those fields which are not aligned with the anatomy being examined.

For spot film operation field select is automatic and no change in the field select buttons is required.

When no ion chamber has been selected, or when a three field chamber has been selected and no field selection has been made exposures will be inhibited. To correct this condition check for proper x-ray tube selection and field selection on the generator console.

DENSITY CONTROL (Located on generator console).

N - Normal density setting

-25, -50 - Reduction of density (lighter) by approximately 25% or 50% of the mAs exposure at "N".

+25, +50 - Increase of density (darker) by approximately 25% or 50% of the mAs exposure at "N".

This is routinely set at Normal where the system was calibrated for proper film density. It is used to satisfy particular preferences of individual radiologists for darker or lighter than normal films or in cases where special circumstances may require other than normal density films.

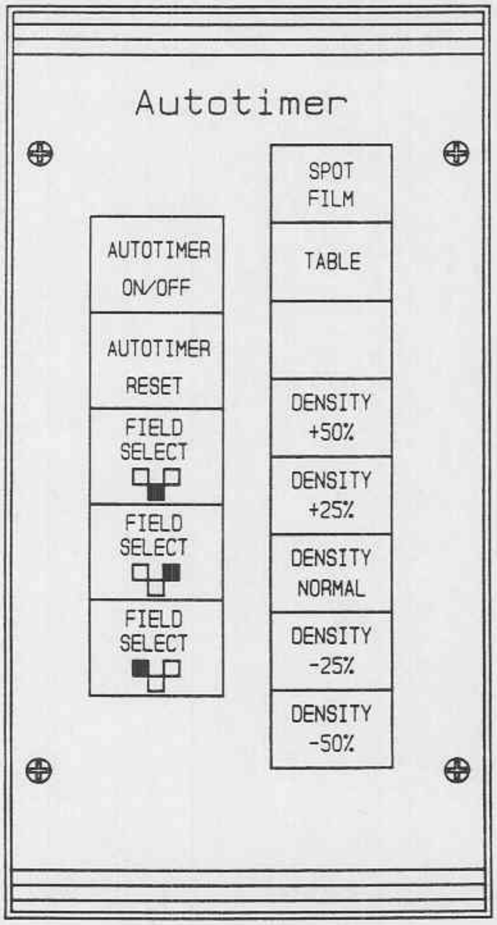
RESET (Located on generator console)

The **RESET** button will light when the exposure has been **terminated** by either the mAs limit set on the generator or by **the Expos-AID** AEC maximum mAs safety limit (569.6 mAs).

The need to activate the RESET control should be interpreted by the operator as a potential radiation safety warning. Determine and correct the cause of the improper exposure termination, then depress the "Reset" button to permit another exposure.

Figure 2.1

Operator Controls


Autotimer
SPOT FILM
TABLE
AUTOTIMER ON/OFF
AUTOTIMER RESET
DENSITY +50%
FIELD SELECT
DENSITY +25%
FIELD SELECT
DENSITY NORMAL
FIELD SELECT
DENSITY -25%
DENSITY -50%

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3.0 SPECIFICATIONS

The following specifications apply to performance of the Expos-AID Model A3365-G Automatic Exposure Control System for use with the Continental Concorde 650 x-ray generator.

3.1 System Performance

kVp Range/Optical Density (OD) Tracking:

kVp Range	Phantom Thickness (inches)	Optical Density Variation ± OD from mean
50- 65	4	0.25
65- 80	8	0.15
80- 95	9	0.15
95-110	10	0.15
110-150	12	0.25

Performance with exposure time below 5ms not guaranteed. AID can supply a forced extinction package for most single phase generator systems not already equipped with forced extinction. Without forced extinction, performance for short exposure times will be limited due to exposure termination only at zero crossings.

Temporal Characteristics:

Response Time	± 1.0 mS
Exposure Duration Compensation	-0.3mAs factory set 0 to -0.7mAs range
Default Termination	569.6 mAs

Display of mAs is accurate to ± 5%, as measured by a Machlett Dynalyzer.

Screen-Film Speed:

Generally, screen-film combinations from approximately 50 to 600 may be accommodated. Variations in screen-film combinations make it difficult to be more specific, but even greater range may be possible.

kVp Compensation:

kVp compensation adjustments are made at five kVp calibration set points. For 50 to 150 kVp generators these are 50, 75, 100, 125 and 150 kVp. For 50 to 125 kVp generators these are 50, 70, 90, 110 and 125 kVp.

Dynamic Range:
Source to image distance (SID) 36-72 inches.
X-ray tube current to 1200mA.
kVp generator fluctuations ± 20%.

3.2 Ion Chamber

Input	+12VDC and -12VDC
Sensitivity (Nominal)	40V/mR
Maximum Output	8.5VDC
Drift & Noise	<30mV/10 seconds
Linearity	± 0.5%
Ion Chamber Field Size	Chest and Table chamber 2" x 4.4" center field 2.2" x 3.6" outer fields 3" square, spot film chamber
Ion Chamber Potential	200VDC ± 5% (internally generated)
Reproducibility	≤ 0.05 Coefficient of Variation

3.3 Controls and Displays

Digital Display (Internal)
3 1/2 Digit, 0.4" LED Display of mAs after exposure.

Density Control (External)
Selection of ± 25% or ± 50% change in mAs from the Normal setting (N).

Field Selection (External)
For three field ion chambers, any combination of three fields is selectable.

Exposure Termination Indicators (Internal)

AEC LED (61017 L1)
- Termination by Automatic Exposure Control.

GEN LED (61017 L2)
- Termination by generator timer set for backup.

mAs LED (61017 L3)
- Termination by Expos-AID AEC maximum mAs limit.

Reset (External)

Momentary switch used to clear fault conditions (exposure inhibit caused by GEN termination or mAs termination).

3.4 Interface Reqirements

Exposure Start:
A 10-15 VDC or 20-30 VDC signal is required to energize a relay in the Expos-AID AEC upon actual exposure start. Signal loading is less than 30 mA.

Exposure Termination:
Normally-open contacts that close at exposure stop or normally-closed contacts that open at exposure stop. Contacts are rated 0.3 ampere maximum with 100 ohms nominal resistance.

Chamber Selection:
Bucky, chest or spot film chamber selection is made by activating a relay in the AEC. Standard units are supplied with 12 VDC relays.

mA Sense:

7.5 ohm current sensing resistor corresponding to 0.75 VDC at 100 mA. Common mode voltage (CMV) is 100 V, maximum. Calibration range extends to 1200 mA maximum.

kVp Sensing:

A positive DC voltage directly proportional to kVp is used.

3.5 Power Consumption

Voltage:
115/230 VAC ± 10%, 50/60 Hz.

Current Drain:

Maximum Operate	< 100/200 mA @ 230/115 VAC
Standby	< 65/130 mA @ 230/115 VAC
Power Off	< 18/35 mA @ 230/115 VAC

3.6 Physical Parameters

Temperature & Humidity:

Storage: -55 degrees C to +85 degrees C, 95% RH

Operating: 15 degrees C to 40 degrees C, 80% RH

Dimensions, Weight (Nominal):

	Size H x W x L (inches)	Weight (Lbs.)
Interface Chassis	2.75 x 10.5 x 17.0	12.0

3.7 Scheduled Maintenance

Test the Expos-AID AEC annually to see that it meets the kVp Range/Optical Density Tracking specifications listed in Section 3.1. If it does not, then repeat the calibration procedures in Section 5.0. Also test the system whenever the x-ray generator is recalibrated or there is a change in the screen-film combination used.

Visually inspect the Expos-AID cables for signs of wear.

Check cable and PCB connectors to see that they are securely fastened.

3.8 Regulatory Compliance

Center for Devices and Radiological Health

Design and production standards comply with the relevant portions of Section 1020.30 of the Radiation Control for Health and Safety Act of July 1968, when labeled:

> Product complies with D.H.E.W./F.D.A.
> Performance Standard 21 CFR
> Subchapter J.

4.0 INSTALLATION INSTRUCTIONS

The Expos-AID Model A3365-G Automatic Exposure Control is a factory installed component. For this reason the installation instructions have been omitted. See Section 3.0 for interface signal requirements. See Section 5.0 for field calibration instructions.

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5.0 FIELD CALIBRATION INSTRUCTIONS

The purpose of the calibration procedure in this chapter is to match the Expos-AID AEC exactly to the generator and to the x-ray absorption characteristics of the screen-film combination to be used with that generator.

The kVp Level Adjustment (Section 5.3) matches the Expos-AID AEC kVp measuring circuitry to the generator kVp range.

The Chamber Gain Adjustment, and Input Amplifier Gain Adjustment (Section 5.4) match the Expos-AID AEC to the screen-film combination near the midpoint of the kVp range.

The kVp Compensation procedure (Section 5.6) then completes the matching of the Expos-AID AEC to the screen-film combination by fine tuning four additional kVp set points on the kVp compensation curve. The fine tuning is accomplished by making an X-ray exposure, measuring the resultant optical density of the film, adjusting (if necessary) each kVp set point according to a simple formula, and then rechecking with another exposure.

Equipment Required

X-ray Apparatus

-- X-ray Generator, known to be in good working order and having reasonably good kVp calibration.

-- X-ray Film Processor.

-- X-ray Densitometer capable of measuring optical film density from 0.5 to 2.5 with accuracy of ± 0.05 OD.

-- Expos-AID AEC, fully installed, including interface chassis, and ion chamber(s).

-- Film, Cassettes - provide film, and a cassette. Use the same cassette throughout the entire calibration procedure.

-- A water Phantom, - use a clean flat-bottomed plastic bucket (minimum diameter of 6") which can be filled with up to 12" of tap water.

Electronic Equipment

- -- Digital Voltmeter, 3-1/2 digits, 20 VDC range, 10 Mohm input impedance, preferably a type allowing battery operation. Probes equipped with clips and probe points.
- -- Small Screwdriver for potentiometer adjustments.
- -- Oscilloscope - DC to 1 MHz min., 0.1VDC/cm (preferably a storage type oscilloscope).

Other Required Material

- -- Scale appropriate to measure a water depth of up to 12 inches.
- -- Tap water
- -- Lead apron

5.1 Preliminary Steps

Refer to Figures 5.1 and 5.2 for adjustment component locations.

Interface Board Access

- -- Remove interface chassis cover to facilitate adjustments.
- -- Ensure that the Expos-AID AEC ion chamber and cables, the mA cable, the kVp cable, the generator interface cable and the control/display cable are connected to the interface chassis.

X-ray Tube/Arm

Position the X-ray tube head for a 40 inch SID or for a normal examination as required.

5.2 **Caution**

CERTAIN TESTS REQUIRE THE PRODUCTION OF X-RAYS. FIELD PERSONNEL SHOULD TAKE PRECAUTIONS TO ENSURE THEIR PERSONAL SAFETY AND THE SAFETY OF OTHERS IN CLOSE PROXIMITY. MINIMUM PRECAUTIONS FOLLOW:

- -- Wear lead aprons.
- -- For stationary AEC installations personnel should be behind shield during X-ray emission.
- -- Minimize radiation scatter through doorways, walls, and floor.

Figure 5.1

Adjustment Component Locations

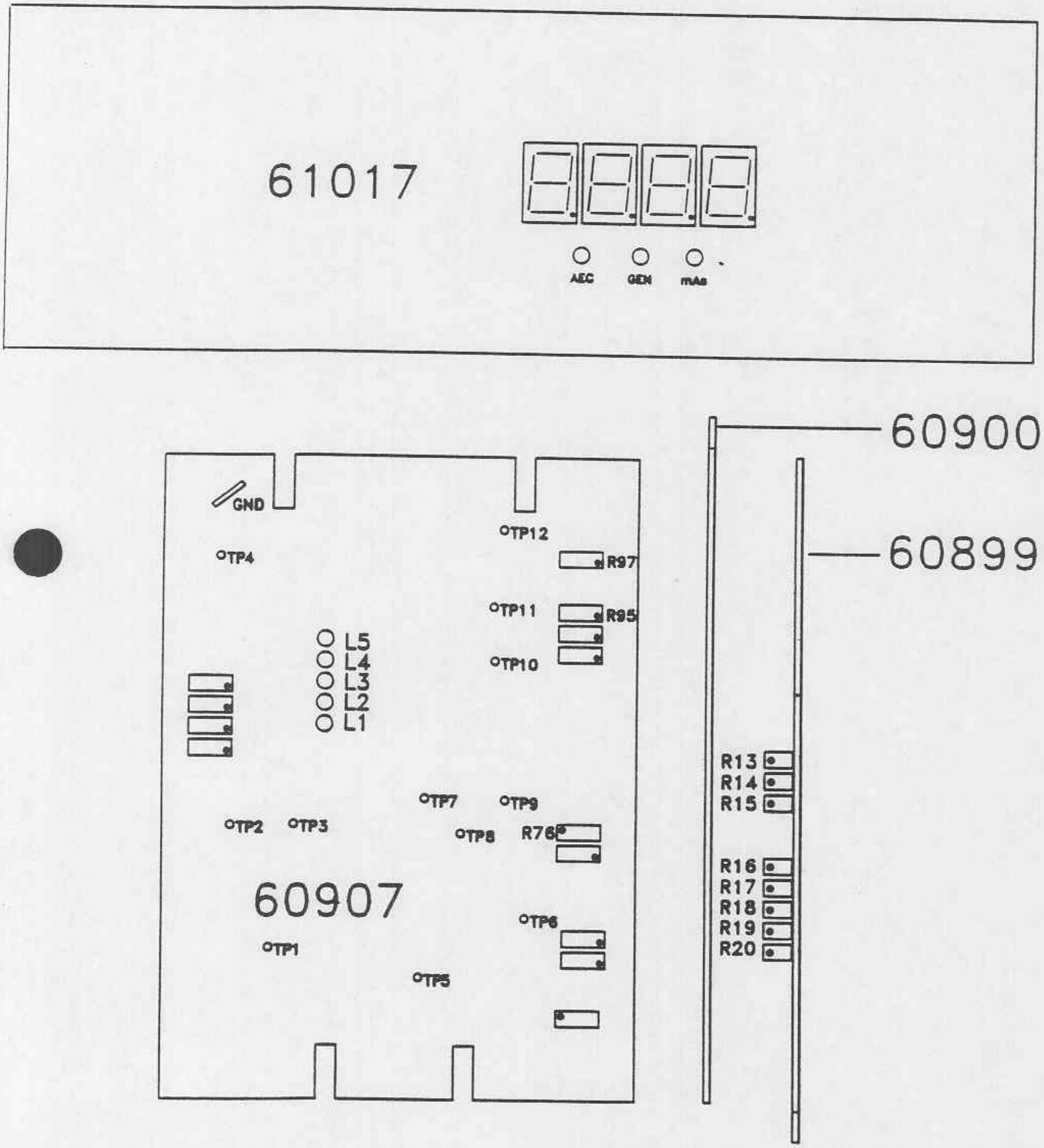
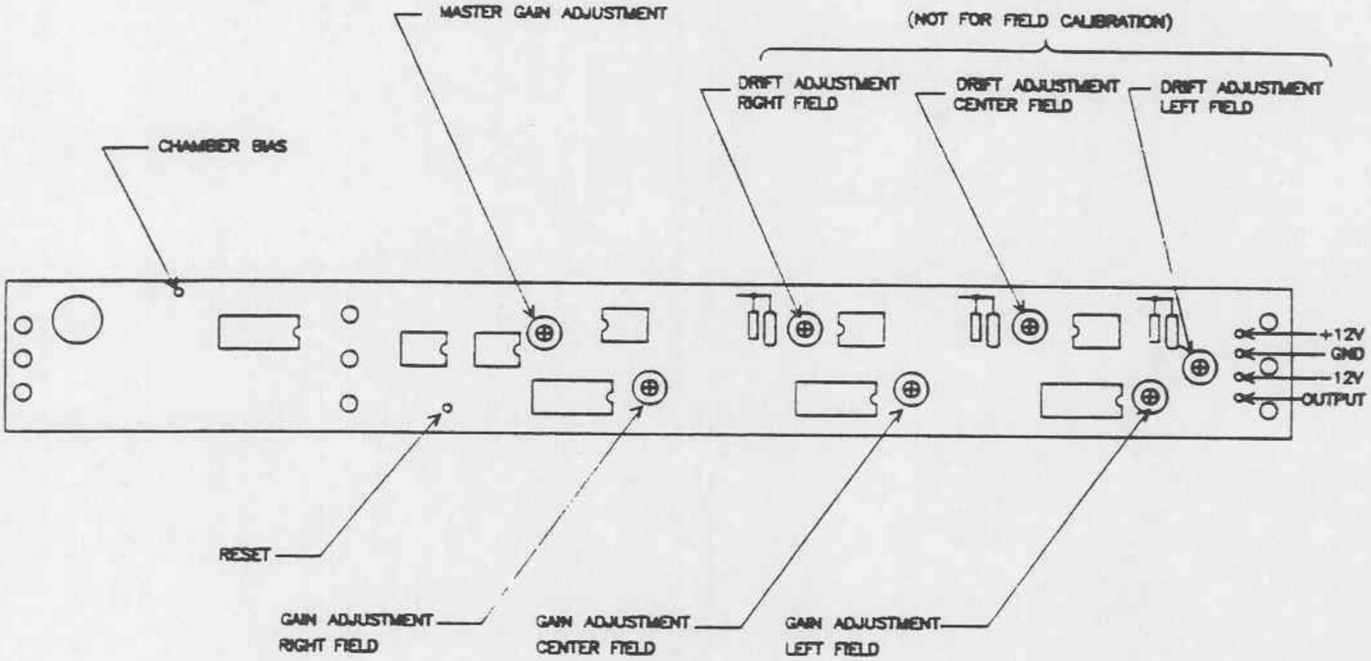
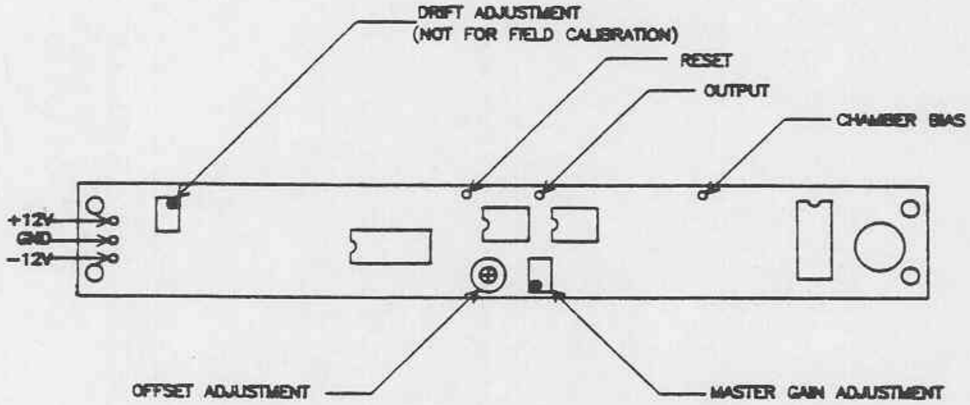

61017
AEC
GEN
mAs
60900
60899
GND
TP12
TP4
R97
TP11
R95
L5
L4
L3
L2
L1
TP10
R13
R14
R15
TP7
TP9
TP2
TP3
TP8
R76
R16
R17
R18
R19
R20
60907
TP6
TP1
TP5

Figure 5.2

Preamplifier Adjustment Component Locations


MASTER GAIN ADJUSTMENT
(NOT FOR FIELD CALIBRATION)
CHAMBER BIAS
DRIFT ADJUSTMENT RIGHT FIELD
DRIFT ADJUSTMENT CENTER FIELD
DRIFT ADJUSTMENT LEFT FIELD
+12V
GND
-12V
OUTPUT
RESET
GAIN ADJUSTMENT RIGHT FIELD
GAIN ADJUSTMENT CENTER FIELD
GAIN ADJUSTMENT LEFT FIELD

PREAMPLIFIER BOARD 60917


DRIFT ADJUSTMENT
(NOT FOR FIELD CALIBRATION)
RESET
OUTPUT
CHAMBER BIAS
+12V
GND
-12V
OFFSET ADJUSTMENT
MASTER GAIN ADJUSTMENT

PREAMPLIFIER BOARD 60940

5.3 kVp Level Adjustment

This procedure matches the Expos-AID AEC kVp selection circuitry to the actual kVp output levels of the generator.

Note: kVp settings not in parenthesis are for 150kVp generators.
kVp settings in parenthesis are for 125kVp generators.

1. Turn generator on.
   Turn AEC on.
   Select Normal density.
   Switch on 60907 SW3 to light LED (kVp level indicators).
2. Select 100kVp (90kVp).
   Adjust 60907 R97 so that LED 60907 L3 just goes out and LED 60907 L4 just comes on.
3. Select 125kVp (110kVp).
   Adjust 60907 R95 so that LED 60907 L4 just goes out and LED 60907 L5 just comes on.
4. Select 100kVp (90kVp).
   Adjust 60907 R76 so that LED 60907 L3 just goes out and LED 60907 L4 just comes on.

5.4 Chamber Gain (Main Density) Adjustment

DO NOT OVERLOOK THE NEED FOR PERSONNEL SAFETY DURING EXPOSURES.

In this procedure, X-ray exposures with the appropriate AEC chamber will be required. Extensive use will be made of the X-ray tube's collimator light to position the phantom and film. Collimate near the center of the phantom. Maintain the same SID throughout the calibration procedure.

Note: Figures not in parenthesis are for 150kVp generators.
Figures in parenthesis are for 125kVp generators.

1. **Set the generator at 100kVp (90kVp) and 320 mAs backup.**
   Select Density N (Normal).
   Select Center Field alone.
2. Position the phantom [10 inches (8 inches) of water or equivalent] and the center field of the chamber in line with the collimator light.

3. Place a cassette with an unexposed sheet of film in the cassette holder. Make an x-ray exposure. Record the mAs reading on the 61017 display board.
4. Develop the film and measure and record the average optical density (OD) near the center of the exposure.

5. If the optical density is 1.20 ± 0.05, proceed to Step 8.

   If the optical density is not 1.20 ± 0.05, continue with Step 6.

6. Determine an approximate value of mAs to correspond to OD = 1.20 by using the following equation:

$$\text{New mAs} = \frac{1.20}{\text{OD (from Step 4)}} \times \text{Old mAs (from Step 3)}$$

7. Repeatedly make exposures with the loaded film cassette until adjustment of the preamplifier master gain produces the mAs reading calculated in Step 6. Repeat Steps 3 through 5. Refer to Figure 5.2 for preamplifier master gain adjustment locations.

8. Select the second or third system entrance-type chamber, if used. Repeat Steps 1-5 for that chamber using the same screen-film combination.

5.5 Field Matching

The output of individual fields of three-field chambers is calibrated at the factory. It may, however, be necessary to fine tune this adjustment in the field. It is important that field matching be done based on the optical density of actual exposures rather than merely on mAs readings because of the effects of grids, anode-heel effects and backscatter. Therefore, it will be necessary to make exposures, process films, and measure optical densities in order to precisely match the three fields.

Make sure the phantom used is homogeneous and completely covers all three fields. Make sure the beam is collimated to cover all three fields equally. Repeat the steps in Section 5.4 making adjustment to the individual field gains instead of the master gain on the chamber preamplifier.

Refer to Figure 5.2 for preamplifier field gain adjustment locations.

5.6 kVp Compensation

This procedure requires the prior calibration of chamber gain as given in Section 5.4. X-ray exposures and use of the system's collimator light will be required.

1. Select Density N (Normal).
   Select Center Field alone.
2. Set the generator at maximum mAs.
3. Select one of the generator kVp settings and a corresponding phantom thickness from Table 5.1.

Table 5.1 kVp Compensation Setting

Generator kVp setting	Phantom Thickness in inches	CRV Adjustment Potentiometer on PCB 60899	Final CRV Settings 60907 TP1
50 (50)	5 (5)	R16	---------
75 (70)	7 (7)	R17	---------
125 (110)	12 (11)	R19	---------
150 (125)	12 (12)	R20	---------

Note: Figures not in parenthesis are for 150kVp generators.
Figures in parenthesis are for 125kVp generators.

4. Place a film cassette in the cassette holder. Use the collimator light to align the phantom and tube head with the center field of the ion chamber.
5. Measure the Compensation Reference Voltage (CRV) for the selected kVp at 60907 TP1.
6. Make an x-ray exposure at the selected kVp with a loaded film cassette.
7. Develop the film and measure the average Optical Density (OD) near the center of the exposure.

   If the OD is 1.20 ± 0.05, record the CRV in Table 5.1 for future reference and proceed to Step 10.

   If the OD is not 1.20 ± 0.05 then continue with Step 8.

8. Use the following equation to calculate a **new** CRV setting to obtain the approximate desired OD.

$$\text{New CRV} = \frac{1.20}{\text{OD (from Step 7)}} \times \text{Old CRV (from Step 7)}$$

9. Adjust the CRV at 60907 TP1 for the selected kVp using the potentiometer on PCB 60899 as indicated in Table 5.1 to give the new CRV which was calculated in Step 8. Repeat Step 6 and Step 7.

10. Repeat Step 3 through Step 7 for all kVp settings listed in Table 5.1 to obtain films with Optical Densities of 1.20 ± 0.05.

5.7 Conclusion of Field Calibration

It is strongly suggested that a diagnostic quality anatomical or radiological phantom be used to provide an initial baseline quality check of the system.

Though not a recommended procedure, if the users desire a "normal" optical density other than provided by the calibration procedure the input amplifier gain (60899 R15) can be adjusted appropriately.

If the optical densities obtained when a second or third chamber position is selected are generally considered too light or dark adjust only the master gain at that chamber's preamplifier. However, if a diagnostically correct field selection for a particular chamber produces a light or dark film, while another diagnostically correct field on the same chamber gives a good film, adjust only the field gain requiring attention. Refer to Figure 5.2 for preamplifier master gain and field gain adjustments.

The Expos-AID Automatic Exposure Control system is now calibrated and ready for use. Refer to Section 2.0 for operator instructions.

6.0 PRINCIPLES OF OPERATION

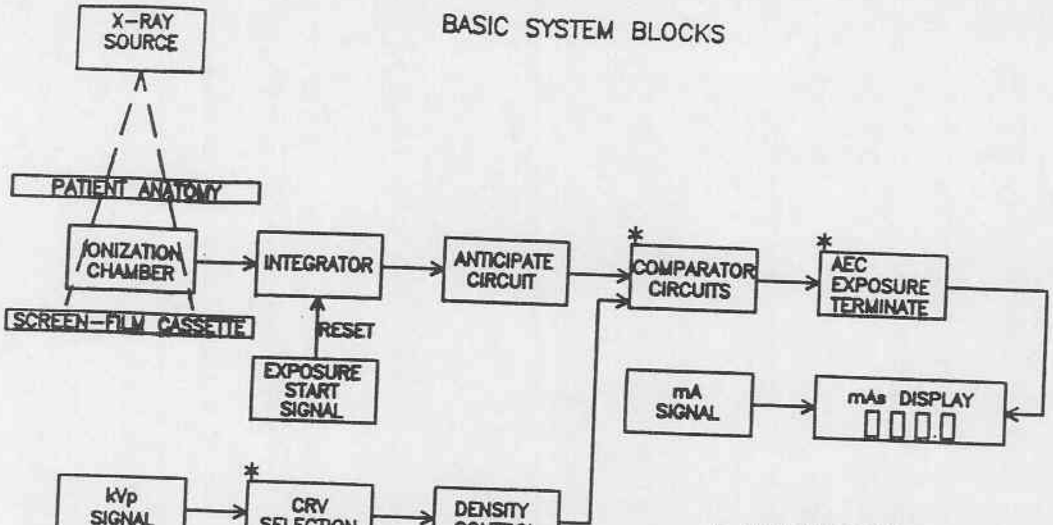
The following sections are intended to provide service personnel with a basic understanding of the key elements of the Expos-AID AEC system.

6.1 Basic System Blocks (Refer to Figure 6.1)

- X-ray source
- Patient anatomy
- Screen-film cassette
- Chamber - The integrator is held in a reset condition until the start of an exposure, at which time the reset is removed. The X-rays produce a small ion current which is integrated, preamplified and transmitted to the Input Amplifier Board #60899 in the interface chassis.
- Switching circuitry - Remotely activated at the generator console to select field combinations for multi-field chambers.
- Screen-film absorption matching circuitry (5 points) - The kVp signal is processed to select a Calibration Reference Voltage (CRV) from the calibrated kVp response curve.
- Calibration Adjustments (60899 R16-R20) are made at five kVp set points to establish the kVp response curve.
- The anticipate circuit detects the rate of change of the time-integrated output voltage. The anticipate circuit then provides a compensation signal to terminate the x-ray exposure about 3 milliseconds prior to normal extinction to compensate for inherent turnoff delays in the generator.
- The comparator terminates the exposure and updates the mAs display.
- The x-ray tube current as sensed by mA(+) and mA(-) is converted to a proportional DC signal and routed through to the mAs display's 500Hz per 1VDC voltage-to-frequency converter.

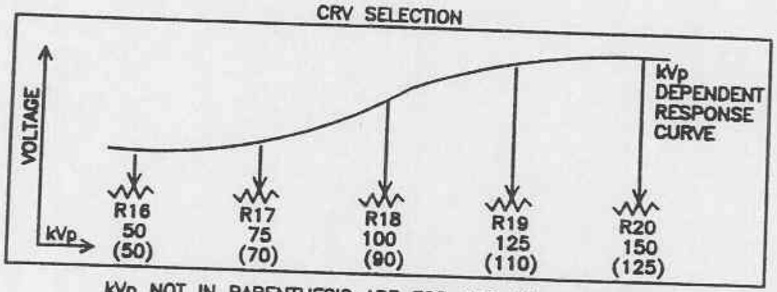
FIGURE 6.1

BASIC SYSTEM BLOCKS


X-RAY SOURCE
PATIENT ANATOMY
IONIZATION CHAMBER
SCREEN-FILM CASSETTE
INTEGRATOR
RESET
EXPOSURE START SIGNAL
ANTICIPATE CIRCUIT
* COMPARATOR CIRCUITS
* AEC EXPOSURE TERMINATE
mA SIGNAL
mAs DISPLAY
kVp SIGNAL
* CRV SELECTION
DENSITY CONTROL

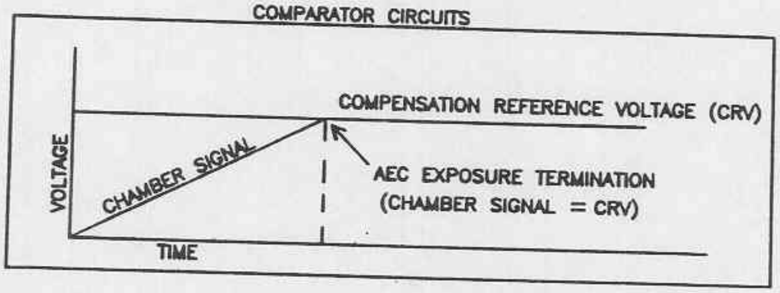
* SEE FIGURES BELOW

CRV SELECTION

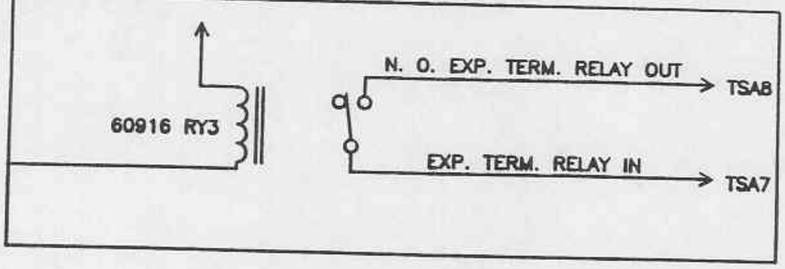

VOLTAGE
kVp
kVp DEPENDENT RESPONSE CURVE
R16 50 (50)
R17 75 (70)
R18 100 (90)
R19 125 (110)
R20 150 (125)

kVp NOT IN PARENTHESIS ARE FOR 150 kVp GENERATORS
kVp IN PARENTHESIS ARE FOR 125 kVp GENERATORS

COMPARATOR CIRCUITS


COMPENSATION REFERENCE VOLTAGE (CRV)
VOLTAGE
CHAMBER SIGNAL
AEC EXPOSURE TERMINATION
(CHAMBER SIGNAL = CRV)
TIME

AEC EXPOSURE TERMINATE


60916 RY3
N. O. EXP. TERM. RELAY OUT
TSA8
EXP. TERM. RELAY IN
TSA7

6.2 Diagnostic/Troubleshooting Guide

The following is a list of possible problems and their likely corrections. The list is not all-inclusive, but covers field serviceable problems. Additional questions should be refered to the factory or service center. It is assumed that the X-ray Generator is in proper working order, and this should be confirmed by normal manual operation of the generator after simply switching off the Expos-AID AEC.

Preliminary Checks:

Check to see that the x-ray generator operates properly with the Expos-AID AEC power turned off.

Check to see that all cable connectors are securely fastened and held in place with appropriate hardware. Also check to see that all cables are routed and secured to avoid sharp edges and moving parts.

Check to see that all circuit boards are plugged correctly into their proper connectors.

Check the line fuse to see that it is good.

SYMPTOM: Generator will not make exposures.

Check to see that a chamber is selected.

- Check 60916 TSB pins 5, 3 or 1 for 0VDC from the generator interface to select chambers 1, 2 or 3 respectively.
- Check to see that relays 60916 RY5, RY6 or RY7 are energized by the 0VDC chamber select signals at TSB.

Check to see that a chamber field is selected.

- Check for 0VDC at the cathode of 60916 D9, D10 or D11 to select the left, center or right fields respectively.

Check the 61017 Expos-AID Display board LED termination indicators. If the generator termination LED, 61017 L2, or the mAs termination LED, 61017 L3, is lit, then refer to the sections for these particular symptoms.

SYMPTOM: AEC does not terminate the exposure.

If the AEC termination LED, 61017 L1, lights after the exposure but the AEC does not terminate the exposure, then the AEC is working, but the terminate signal is not getting through to the generator. Check the following points while 61017 L1 is lit to isolate the problem.

- 60900 pin 5; high (12VDC) to low (0VDC).
- 60916 B Connector pin B; high (12VDC) to low (0VDC).
- 60916 TSA pins 7 and 8; contact closure of 60916 RY3 normally open contacts.

If no 61017 LED termination indicator comes on after the exposure, then check to see if the 61017 mAs display goes from dim to bright at the start of the exposure. If the 61017 mAs display does not get brighter at exposure start, this indicates that the exposure start signal from the generator is not being recognized by the Expos-AID. Use an oscilloscope to check the following signals for the duration of each exposure to try to isolate the problem. These should be clean DC level signals.

- 60916 TSA across pins 3 and 4; low (0VDC) to high (12VDC).
- 60916 B Connector pin 4; high (12VDC) to low (0VDC).
- 60900 pin 1; high (12VDC) to low (0VDC).
- 60900 pin 2; low (0VDC) to high (12VDC).
- 61017 pin 7; low (0VDC) to high (12VDC).
- 61017 D1 (anode); low (0VDC) to high (5VDC).

SYMPTOM: Generator termination LED, 61017 L2, is lit.

This is a lockout condition which prevents further x-rays.

- Press the AEC Reset button to clear this condition.

The generator back-up time (mAs setting) may be too short.

- Set the backup mAs to about 4x the expected value.

The generator x-ray output may be low.

- Check the generator kVp setting.
- Check the collimation and tube alignment.

The appropriate chamber may not be selected.

- Check 60916 TSB pins 5, 3 or 1 for 0VDC from the generator interface to select chambers 1, 2 or 3 respectively.
- Check to see that relays 60916 RY5, RY6 or RY7 are energized by the 0VDC chamber select signals at TSB.

The appropriate field may not be selected.

- Check these selections at the generator console.
- Check for 0VDC at the cathode of 60916 D9, D10 or D11 to select the left, center or right fields respectively.

The chamber cables may be damaged or disconnected.

- Check the continuity and repair or replace as needed.

The chamber may be damaged or disconnected.

- Check the chamber output at 60899 TP1 using a storage oscilloscope. Look for a positive ramping signal rising from 0.00VDC during an exposure.

Perhaps the exposure start signal is being removed before AEC termination occurs. Use an oscilloscope to check for clean DC level signals for the entire duration of an exposure to try to isolate the problem.

- 60916 TSA across pins 3 and 4; low (0VDC) to high (12VDC).
- 60916 B Connector pin 4; high (12VDC) to low (0VDC).
- 60900 pin 1; high (12VDC) to low (0VDC).

Once the problem has been resolved press RESET to clear the generator termination LED, 61017 L2.

SYMPTOM: mAs termination LED, 61017 L3, is lit.

This indicates that the Expos-AID AEC terminated the exposure at its maximum allowable mAs, 569.6mAs.

Look for the same problems listed above for generator termination LED.

The "mAs" LED may also light before an exposure if one of the circuit boards is not secure in its connector.

Once the problem has been resolved press RESET to clear the "mAs" LED.

SYMPTOM: Erratic mAs display readouts.

Check to see that the film's Optical Density (OD) remains relatively constant (1.20 OD ± 0.15 OD) from shot to shot in spite of changes in mAs. If not:

- Check the AEC regulated power supplies with respect to ground, 60916 TP1.

  +12VDC ± 0.6VDC at 60916 TP2.

  -12VDC ± 0.6VDC at 60916 TP3.

- Check the connections of the chamber and chamber cables.
- Check the chamber output at 60899 TP1 using a storage oscilloscope. Look for a positive ramping signal rising from 0.00VDC during an exposure.
- For single-phase generators without forced extinction, a single pulse should not account for a significant percentage (>10%) of the overall exposure.

SYMPTOM: **Exposures are uniformly too light or too dark at all kVp settings.**

The **density switch** setting may be incorrect.

- Adjust density switch setting as needed.

The Chamber Gain Adjustment may be incorrect.

- Repeat the calibration procedures for the chamber Gain Adjustment (Section 5.4).

SYMPTOM: Exposures are too light or too dark at **some** kVp settings.

The kVp compensation may be incorrect.

- Recheck the kVp Level Adjustment in Section 5.3.
- Recheck the kVp Compensation Adjustments in Section 5.6.

The kVp selected may be too low for the anatomy being radiographed.

- Check the chamber output at 60899 TP1 using a storage oscilloscope. Look for a positive ramping signal rising from 0.00VDC during an exposure.
- Use a higher kVp setting.
- If calibrating, use a thinner phantom.

The kVp selected may be too high for the anatomy being radiographed. Operation of the Expos-AID AEC is not recommended for exposures less than 5ms.

- Use a lower kVp setting.
- Use a larger SID.
- Use a slower speed screen-film combination.
- If calibrating, use a thicker phantom.

6.3 Factory Calibration Instructions

These adjustments are not required as a part of the initial installation and calibration sequence. They are included only for service checks and/or repairs. Refer to Figure 6.2 for factory adjustment component locations. If any of these adjustments are made, it will be necessary to repeat the Field Calibration Adjustments described in Section 5.0 in order to match the user's specific needs.

Equipment Required:

74047	Expos-AID AEC interface chassis Including PC Boards:

60899	Input Amplifier board
60900	Logic Control board
60905	Interconnection board (lower)
60907	kVp Computer board
60916	Power Supply board
60932	Interconnection board (upper)
61017	Display board with cable
61061	Connector board
61063	6-Pin Connector board
61064	12-Pin Connector board

ICX 159	Three Field Ionization Chamber (optional)
ICX 178	Spot Ionization Chamber (optional)

Test equipment required:

-- Small Screwdriver for potentiometer adjustments.

-- Three (3) 12 inch (30cm) clip lead jumpers with miniature clips.

-- One (1) 47k ohm 1/4W resistor.

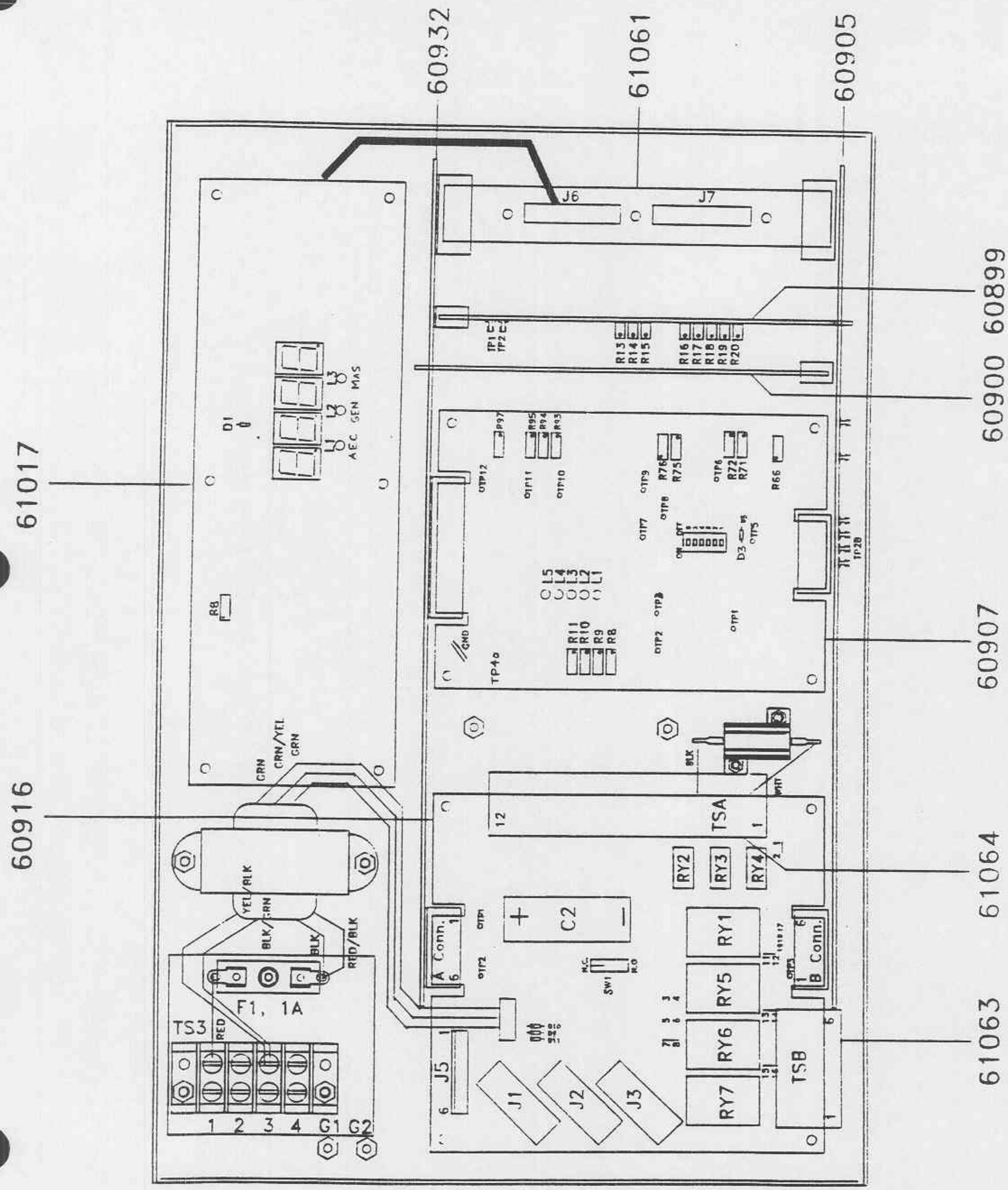
-- Oscilloscope - DC to MHz min., 0.1VDC/cm (preferably a storage type oscilloscope).

-- Digital Voltmeter, 3-1/2 digits, 20VDC range, 10 Mohm input impedance. Preferably a type allowing battery operation. Probes equipped with clips and probe points.

All oscilloscope and meter readings are referenced to circuit common at 60916 TP1 unless noted otherwise.

Figure 6.2

Factory Adjustment Component Locations


60932
61061
60905
61017
60899
60900
60907
60916
61064
61063
J6
J7
D1
AEC GEN MAS
R8
GRN
GRN/YEL
GRN
YEL/BLK
BLK/GRN
BLK
RED/BLK
RED
F1, 1A
TS3
1 2 3 4 G1 G2
TP1
TP2
R13
R14
R15
R16
R17
R18
R19
R20
L5
L4
L3
L2
L1
R11
R10
R9
R8
GND
TP40
R66
R71
R72
R75
R76
D3
TP28
BLK
WHT
TSA
12
1
RY2
RY3
RY4
RY1
RY5
RY6
RY7
C2
A Conn.
B Conn.
SW1
J5
J1
J2
J3
TSB

Index of Expos-AID AEC Adjustment Potentiometers:

PCB	Potentiometer	Description	Page
60899:	R13	Input Amplifier Offset	6-11
	R14	System Gain	6-11
	R15	System Gain	6-11
	R16	CRV Adjustment 50kV - 74kV	6-11
	R17	CRV Adjustment 75kV - 99kV	6-11
	R18	CRV Adjustment 100kV - 124kV	6-11
	R19	CRV Adjustment 125kV - 149kV	6-11
	R20	CRV Adjustment 150kV	6-11
60907:	*R8	Multiplier Gain	6-13
	*R9	Multiplier Y Offset	6-12
	*R10	Multiplier Z Offset	6-12
	*R11	Multiplier X Offset	6-12
	*R66	Common Mode Adjustment	6-13
	*R71	mA Gain Adjustment	6-15
	R72	Anticipate Adjustment	6-15
	*R75	Minimum Comparator Reference	6-12
	R76	kV Level Lower Reference	6-12
	R93	kV Simulator	6-12
	R94	kV Level Lower Limiter	6-12
	R95	kV Level Upper Reference	6-12
	R97	kV Level Adjustment	6-13
61017:	*R8	VCO Scale Adjustment	6-15

*Indicates potentiometer that must NOT be adjusted during normal field calibration procedures.

Preliminary Steps:

1. Inspect PC boards for solder shorts and physical damage.

2. 60916 jumpers and switches should be hard-wired as follows:

1-2	In	11-12	In
3-4	Out	13-14	In
5-6	Out	15-16	In
7-8	In	17-18-19	Out
SW1	N.C.		

3. Turn OFF all of the Test Mode Switches, 60907 SW1 to SW6.

4. Connect 120VAC to TS3-1 and TS3-3 to turn ON the Expos-AID AEC.

5. Check the following supply voltages:

60916 TP2................+12VDC ± 0.6VDC
60916 TP3................-12VDC ± 0.6VDC

60899 Input Amplifier Board Adjustments:

1. Input Amplifier Offset Adjustment:
   - a) Jumper 60916 TP1 to 60899 TP1.
   - b) Adjust 60899 R13 for 0.00VDC ± 0.01VDC at 60907 TP5.
   - c) Remove the jumper used in this procedure.
2. Input Amplifier Gain Adjustment:
   - a) Adjust 60907 R94 for 1.00VDC ± 0.01VDC at 60907 TP11.
   - b) Jumper 60907 TP11 to 60899 TP1.
   - c) Jumper 60916 TP1 to 60899 edge card connector pin D.
   - d) Adjust 60899 R14 for 4.00VDC ± 0.01VDC at 60899 TP2.
   - e) Remove the jumper between 60916 TP1 and 60899 edge card connector pin D.
   - f) Adjust 60899 R15 for 4.00VDC ± 0.01VDC at 60899 TP2.
   - g) Remove the jumpers used in this procedure.
3. Compensation Reference Voltage (CRV):
   - a) Switch ON all test mode switches, 60907 SW1-SW6.
   - b) Adjust the kVp simulator, 60907 R93, to select the kVp level LED indicators, 60907 L2 to L5.
   - c) Set the CRV at 60907 TP1 by adjusting the corresponding pot on 60899 as indicated in the table below. Tolerance is ± 0.01VDC.

LED	60899 pot	CRV at 60907 TP1
L2	R1	3.60VDC
L3	R2	3.30VDC
L4	R3	3.00VDC
L5	R4	2.60VDC
L5*	R5	2.25VDC

*Switch OFF 60907 SW5 for 60899 R5 adjustment.

   - d) Switch OFF the test mode switches 60907 SW1-SW6.

60907 kVp Computer Board Adjustments:

Begin with all test mode switches 60907, SW1-SW6, OFF.

1. Set 60907 R95 for 5.80VDC ± 0.01VDC at 60907 TP9.
2. Set 60907 R76 for 2.38VDC ± 0.01VDC at 60907 TP7.
3. Set 60907 R94 for 2.20VDC ± 0.01VDC at 60907 TP11.
4. Adjust 60907 R75 for 0.60VDC ± 0.01VDC at the anode of 60907 D3.
5. Turn 60907 SW3 and 60907 SW6 ON.
6. Adjust 60907 R93 through its range to see that the kVp level indicators, 60907 L1 to L5, light sequentially with only one LED lit at a time.
7. Multiplier Alignment:
   - a) Turn 60907 SW2 ON and adjust 60907 R8 for -2.50VDC ± 0.01VDC at 60907 TP3 (preliminary adjustment).
   - b) Jumper 60907 TP4 to ground.
Turn 60907 SW5 ON.
Adjust 60907 R10 for 0.000VDC ± 0.001VDC at 60907 TP2.
   - c) Turn 60907 SW5 OFF.
Adjust 60907 R11 for 0.000VDC ± 0.001VDC at 60907 TP2.
   - d) Turn 60907 SW5 ON.
Remove Jumper from 60907 TP4.
Adjust 60907 R9 for 0.000VDC ± 0.001VDC at 60907 TP2.
   - e) Repeat steps 7. b) through 7. d) until no further adjustment is required on 60907 R10, R11 and R9.
   - f) Turn 60907 SW5 OFF.
   - g) Adjust 60907 R93 for ≥ 0.5VDC at 60907 TP4.
   - h) Adjust 60907 R8 at 60907 TP2 for a DC voltage equal to exactly 1/4 of the voltage at 60907 TP4.
   - i) Turn 60907 SW2 and SW6 OFF.

8. Multiplier Gain Adjustment:

The multiplier gain adjustment requires the use of an oscilloscope that has its horizontal sweep voltage available externally in order to simulate a variable kVp signal.

If the oscilloscope does not have an external sweep voltage a satisfactory sweep voltage may be obtained by periodically connecting and disconnecting 60907 TP12 through a 47K ohm resistor to the positive (+) lead of the 220MFD capacitor 60916 C2 (unregulated +12VDC).

a) Connect the sweep voltage to 60907 TP12. Set the oscilloscope for a sweep rate of 10ms/division and an amplitude of 0.5VDC/division.

b) Adjust 60907 R97 until all the LEDs are sequentially lighted. 60907 SW3 must be ON to enable the kVp LEDs.

c) Monitor the waveform at 60907 TP1. Adjust 60907 R8 (if necessary) to produce a continuous signal composed of straight line segments as the input is swept through the kVp range. Figure 6.3 shows proper and improper adjustments of the multiplier gain.

9. mA Circuitry Alignment:

a) Jumper 60916 TSA-1 to 60916 TSA-2.

b) Adjust 60907 R71 to its mid-position (20 turns CW then 10 turns CCW).

c) Jumper 60916 TSA-1 and 60916 TSA-2 to 60916 TSA-5.

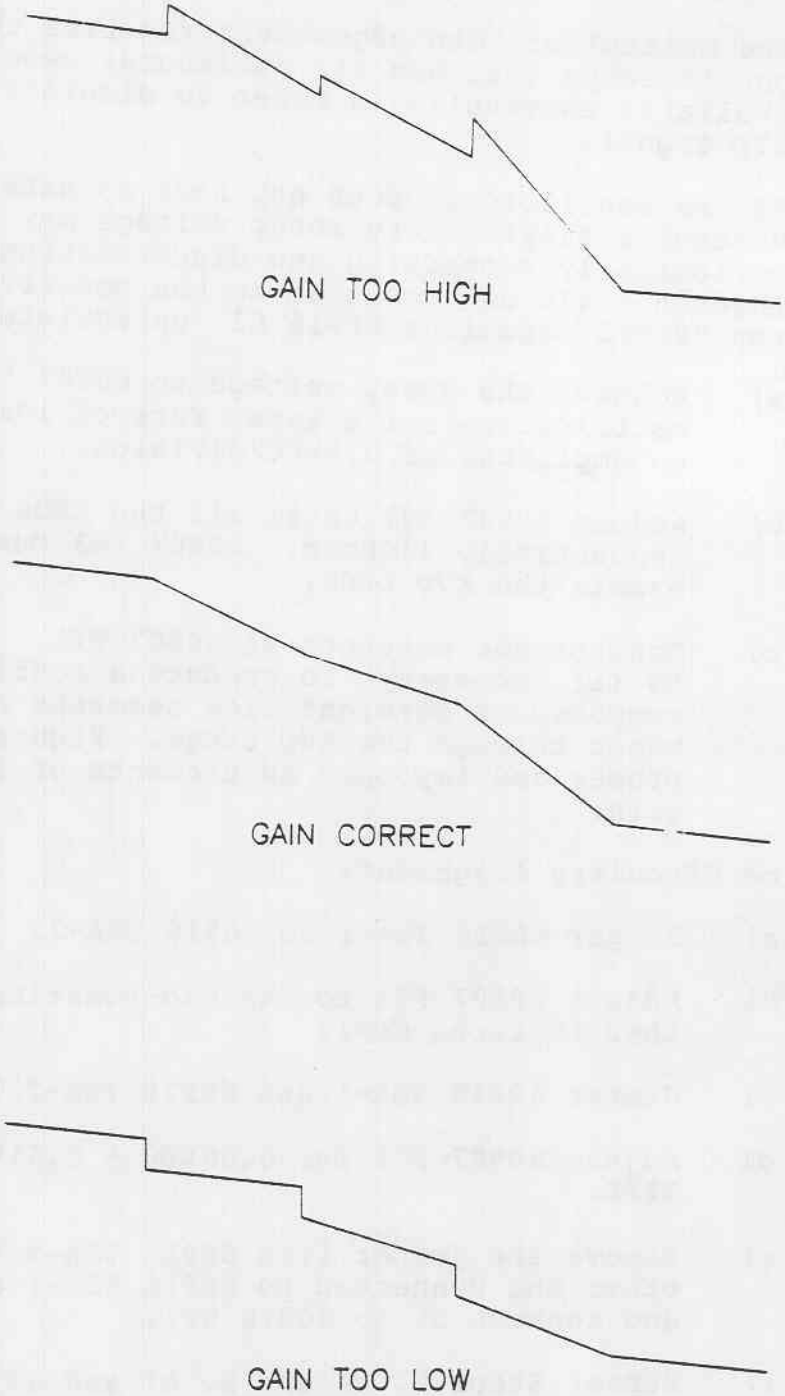
d) Adjust 60907 R66 for 0.00VDC ± 0.01VDC at 60905 TP2B.

e) Remove the jumper from 60916 TSA-5 (leave the other end connected to 60916 TSA-1 and 60916 TSA-2) and connect it to 60916 TP1.

f) Repeat Steps 9. c) and 9. e) and adjust 60907 R66 until there is no change of voltage at 60905 TP2B when the jumper is changed from 60916 TSA-5 to 60916 TP1.

g) Remove all the jumpers used in this procedure.

Figure 6.3 Multiplier Gain Adjustment


GAIN TOO HIGH
GAIN CORRECT
GAIN TOO LOW

60907 R8, MULTIPLIER GAIN ADJUSTMENT
WAVEFORM AT 60907 TP1
VERTICAL = 0.5V/DIVISION
HORIZONTAL = 10ms/DIVISION

10. Check and Align the 61017 Display:

    a) Jumper 60916 TSA-2 to 60916 TP1.

    b) Adjust 60907 R94 for 0.75VDC ± 0.01VDC at 60907 TP11.

    c) Jumper 60907 TP11 to 60916 TSA-1 and, if necessary, readjust 60907 R94 for 0.75VDC ± 0.01VDC at 60907 TP11.

    d) Adjust 60907 R71 for 0.75VDC ± 0.01VDC at 60905 TP2B.

    e) Jumper 60916 TP1 to 60916 B-connector pin D to simulate an exposure start signal.

    f) Monitor 60900 edge card connector pin 2 with an oscilloscope (5VDC/division amplitude and 1sec/division sweep).

    g) Keep the jumper in place until the display reaches the maximum mAs backup (569.6mAs) and the mAs LED, 61017 L3, lights.

    h) Check the simulated exposure duration on the oscilloscope and adjust 61017 R8 (clockwise [CW] to increase time, counterclockwise [CCW] to decrease time) to achieve an exposure duration of 5.7sec ± 0.1sec.

    i) Remove the jumper between 60916 TP1 and 60916 B connector pin D. Momentarily jumper 60900 edge card connector pin C to 60916 TP1 to reset the AEC.

    j) Repeat steps 10. e) through 10. i) until the exposure duration equals 5.7sec ± 0.1sec.

    k) Remove the jumpers used in this procedure.

    l) Readjust 60907 R94 for 2.20VDC ± 0.01VDC at 60907 TP11.

11. Anticipate Adjustment:

    a) Disconnect 120VAC from TS3 of the Expos-AID AEC.

    b) Adjust 60907 R72 for a resistance of 2500 ohms ± 100 ohms between 60907 TP6 and ground.

Ionization Chamber Pre-Amplifier Adjustment Potentiometers:

Refer to Figures 6.4 and 6.5 for adjustment of the ionization chamber preamplifiers.

PCB	Potentiometer	Description	Page
60917:			
	R12	Master Gain Adjustment	6-19
	R15	Right Field Gain Adjustment	6-19
	*R20	Right Field Drift Adjustment	6-18
	R25	Center Field Gain Adjustment	6-19
	*R29	Center Field Drift Adjustment	6-18
	R32	Left Field Gain Adjustment	6-19
	*R37	Left Field Drift Adjustment	6-19
60940:			
	*R1	Drift Adjustment	6-20
	R10	Offset Adjustment	6-20
	R11	Master Gain Adjustment	6-20

*Indicates potentiometer that must NOT be adjusted during normal field calibration procedures.

ICX 159 Three Field Ionization Chamber, 60917 Pre-Amplifier:

1. Connect the ionization chamber and chamber cable to 60916 J1.

2. Connect 120VAC to TS3 of the Expos-AID AEC.

3. Jumper 60916 TP1 to 60916 TSB-5.

4. Check the following power supplies:

60917 pin 8	+12VDC ± 0.6VDC
60917 pin 7	-12VDC ± 0.6VDC
60917 C8 (positive lead)	+5VDC ± 0.3VDC
60917 C9 (negative lead)	-5VDC ± 0.3VDC
60917 C1 (at the cathode of CR6)	+200VDC ± 10.0VDC

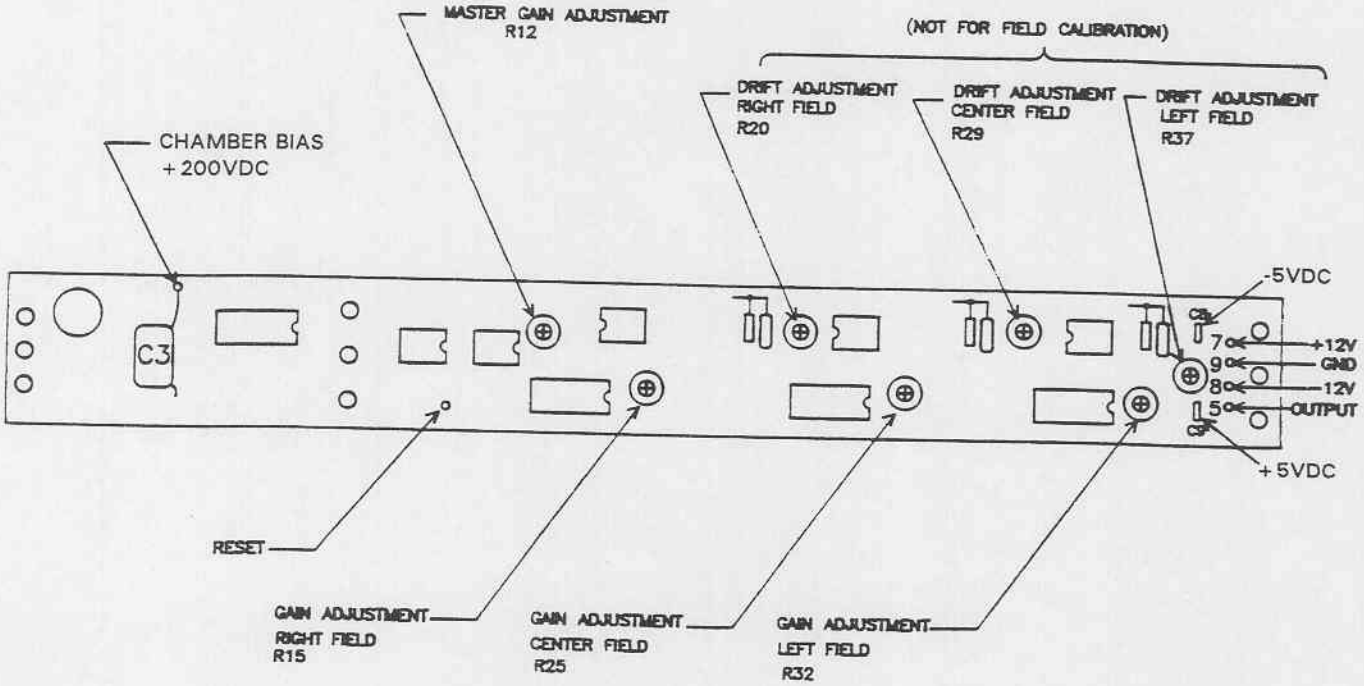
5. Turn all the pre-amplifier gain potentiometers (60917 R12, R15, R25 and R32) CCW to the maximum.

6. Monitor 60899 TP1 with an oscilloscope (50mV/division, 1ms/division).

Figures 6.4 and 6.5

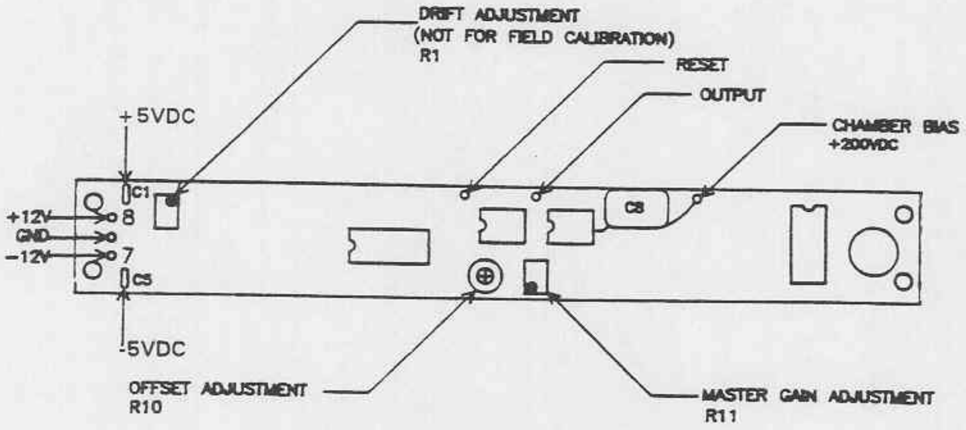
Figure 6.4

Preamplifier Adjustment Component Locations


MASTER GAIN ADJUSTMENT
R12
(NOT FOR FIELD CALIBRATION)
DRIFT ADJUSTMENT
RIGHT FIELD
R20
DRIFT ADJUSTMENT
CENTER FIELD
R29
DRIFT ADJUSTMENT
LEFT FIELD
R37
CHAMBER BIAS
+200VDC
-5VDC
C3
C8
7
+12V
9
GND
8
-12V
5
OUTPUT
C9
+5VDC
RESET
GAIN ADJUSTMENT
RIGHT FIELD
R15
GAIN ADJUSTMENT
CENTER FIELD
R25
GAIN ADJUSTMENT
LEFT FIELD
R32

PREAMPLIFIER BOARD 60917

Figure 6.5


DRIFT ADJUSTMENT
(NOT FOR FIELD CALIBRATION)
R1
RESET
OUTPUT
CHAMBER BIAS
+200VDC
+5VDC
C1
+12V
8
GND
-12V
7
C5
C8
-5VDC
OFFSET ADJUSTMENT
R10
MASTER GAIN ADJUSTMENT
R11

PREAMPLIFIER BOARD 60940

7. Left Field Drift Adjustment:

   a) Jumper 60916 TP1 to 60916 J5 pin 5.

   b) Jumper 60916 TP1 to 60916 Connector B pin D to simulate the start of an exposure.

   c) Adjust the left field drift potentiometer, 60917 R20, for a drift rate ≤ 10mV/second at 60899 TP1 during the first 3 seconds of the simulated exposure.

   d) Remove the jumper from 60916 Connector B pin D.

   e) Jumper 60916 TP1 to 60900 edge card connector pin C to reset the Expos-AID AEC.

   f) Repeat Steps 7. b) to 7. e) until this adjustment is complete.

   g) Remove the jumper from 60916 J5 pin 5.

8. Center Field Drift Adjustment:

   a) Jumper 60916 TP1 to 60916 J5 pin 4.

   b) Jumper 60916 TP1 to 60916 Connector B pin D to simulate the start of an exposure.

   c) Adjust the center field drift potentiometer, 60917 R29, for a drift rate ≤ 10mV/second at 60899 TP1 during the first 3 seconds of the simulated exposure.

   d) Remove the jumper from 60916 Connector B pin D.

   e) Jumper 60916 TP1 to 60900 edge card connector pin C to reset the Expos-AID AEC.

   f) Repeat Steps 8. b) to 8. e) until this adjustment is complete.

   g) Remove the jumper from 60916 J5 pin 4.

9. Right Field Drift Adjustment:

   a) Jumper 60916 TP1 to 60916 J5 pin 6.

   b) Jumper 60916 TP1 to 60916 Connector B pin D to simulate the start of an exposure.

   c) Adjust the right field drift potentiometer, 60917 R37, for a drift rate ≤ 10mV/second at 60899 TP1 during the first 3 seconds of the simulated exposure.

   d) Remove the jumper from 60916 Connector B pin D.

   e) Jumper 60916 TP1 to 60900 edge card connector pin C to reset the Expos-AID AEC.

   f) Repeat Steps 9. b) to 9. e) until this adjustment is complete.

   g) Remove the jumper from 60916 J5 pin 6.

10. Remove all the jumpers used in Steps 1 to 9.

11. Disconnect the 120VAC from TS3 of the Expos-AID AEC.

12. Pre-Amplifier 60917 Gain Adjustments:

    These adjustment potentiometers (60917 R12, R15, R25 and R32) should be adjusted to the midpoints of their respective ranges.

ICX 178 Spot Ionization Chamber, 60940 Pre-Amplifier:

1. Connect the ionization chamber and chamber cable to 60916 J1.

2. Connect 120VAC to TS3 of the Expos-AID AEC.

3. Jumper 60916 TP1 to 60916 TSB-5.

4. Check the following power supplies:

60940 pin 8	+12VDC ± 0.6VDC
60940 pin 7	-12VDC ± 0.6VDC
60940 C1 (positive lead)	+5VDC ± 0.3VDC
60940 C5 (negative lead)	-5VDC ± 0.3VDC
60940 C8 (at the cathode of CR6)	+200VDC ± 10.0VDC

5. Turn the pre-amplifier gain potentiometer, 60940 R11, CCW to the maximum.

6. Monitor 60899 TP1 with an oscilloscope (50mV/division, 1ms/division).

7. Set the pre-amplifier offset adjustment, 60940 R10, for 0.00VDC ± 0.01VDC at 60899 TP1.

8. Spot Field Drift Adjustment:

   a) Jumper 60916 TP1 to 60916 Connector B pin D to simulate the start of an exposure.

   b) Adjust the drift potentiometer, 60940 R1, for a drift rate ≤ 10mV/second at 60899 TP1 during the first 3 seconds of the simulated exposure.

   c) Remove the jumper from 60916 Connector B pin D.

   d) Jumper 60916 TP1 to 60900 edge card connector pin C to reset the Expos-AID AEC.

   e) Repeat Steps 8. a) to 8. d) until this adjustment is complete.

9. Remove all the jumpers used in Steps 1 to 9.

10. Disconnect the 120VAC from TS3 of the Expos-AID AEC.

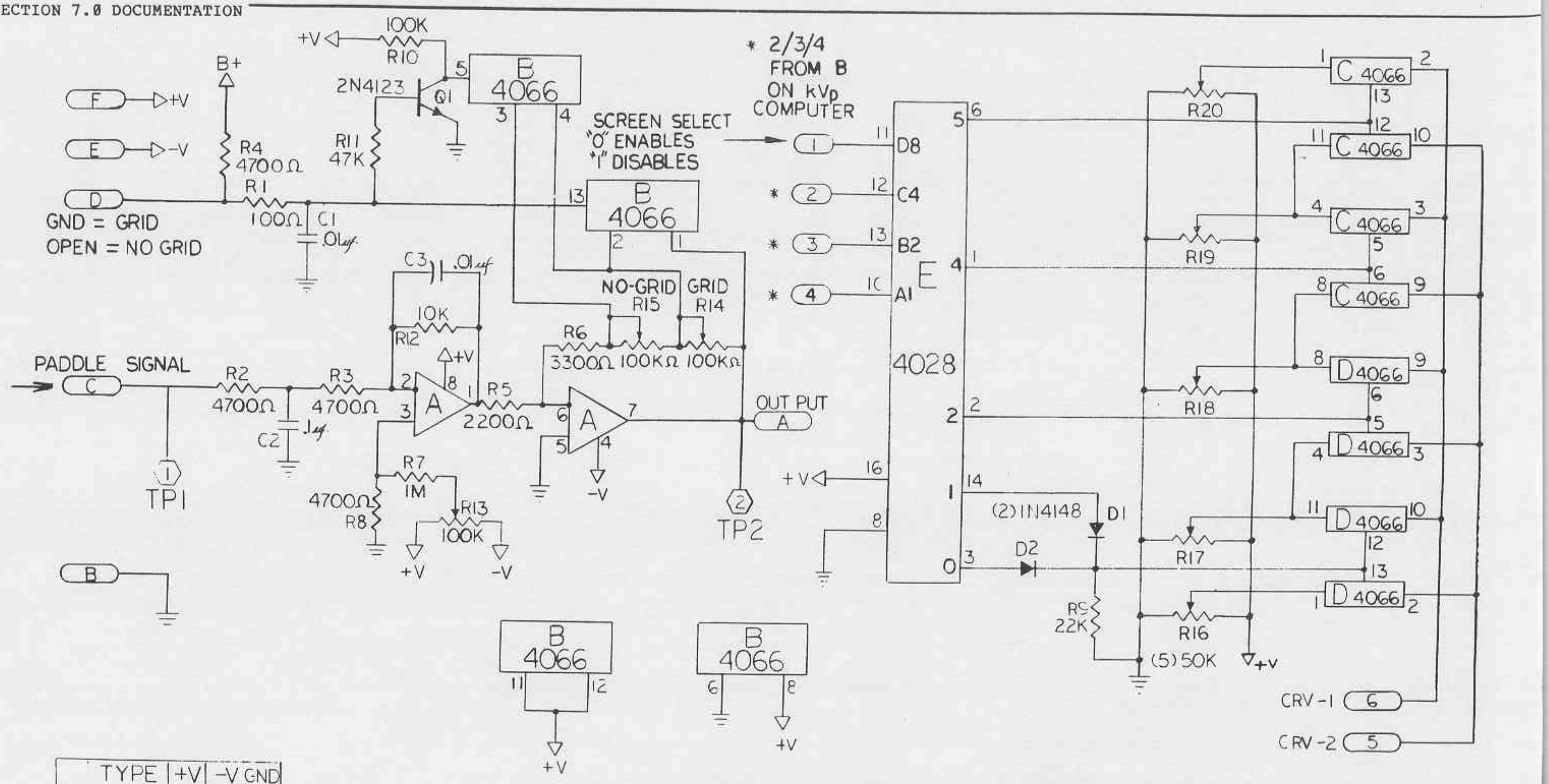
11. Adjust the pre-amplifier gain, 60940 R11, for the midpoint of its range.

Conclusion of Factory and Service Adjustments:

1. Disconnect the 120VAC from TS3 of the Expos-AID AEC.

2. Confirm that all the jumpers are removed and that all the test mode switches, 60907 SW1 to SW6 are in the OFF position.

3. The Expos-AID Automatic Exposure Control is now ready for field calibration (see Section 5.0).


+V
100K
R10
2N4123
Q1
R11
47K
B 4066
5
3
4
B+
F
+V
E
-V
D
R4
4700Ω
R1
100Ω
C1
.01µf
GND = GRID
OPEN = NO GRID
B 4066
13
2
1
* 2/3/4
FROM B
ON kVp
COMPUTER
SCREEN SELECT
"0" ENABLES
"1" DISABLES
1
2
3
4
D8
C4
B2
A1
E
4028
C3
.01µf
10K
R12
+V
NO-GRID
R15
GRID
R14
R6
3300Ω
100KΩ
100KΩ
PADDLE SIGNAL
C
R2
4700Ω
R3
4700Ω
A
R5
2200Ω
A
OUT PUT
A
C2
.1µf
TP1
R7
1M
R13
100K
4700Ω
R8
+V
-V
-V
TP2
B
+V
(2) 1N4148
D1
D2
R9
22K
R20
R19
R18
R17
R16
(5) 50K
+V
C 4066
C 4066
C 4066
C 4066
D 4066
D 4066
D 4066
D 4066
CRV-1
6
CRV-2
5
B 4066
11
12
+V
B 4066
6
8
+V

	TYPE	+V	-V	GND
A	LM1458	8	4	–
B	4066	14	–	7
C	4066	14	–	7
D	4066	14	–	7
E	4028	16	–	8

ECN #463 7/29/86
ECN #222 4/14/82
REVISIONS

SCALE

UNLESS OTHERWISE SPECIFIED:

FRACTIONS	DECIMALS	ANGLES
± 1/64	.xx ± .010 .xxx ± .005	± 1°

MATERIAL

FINISH

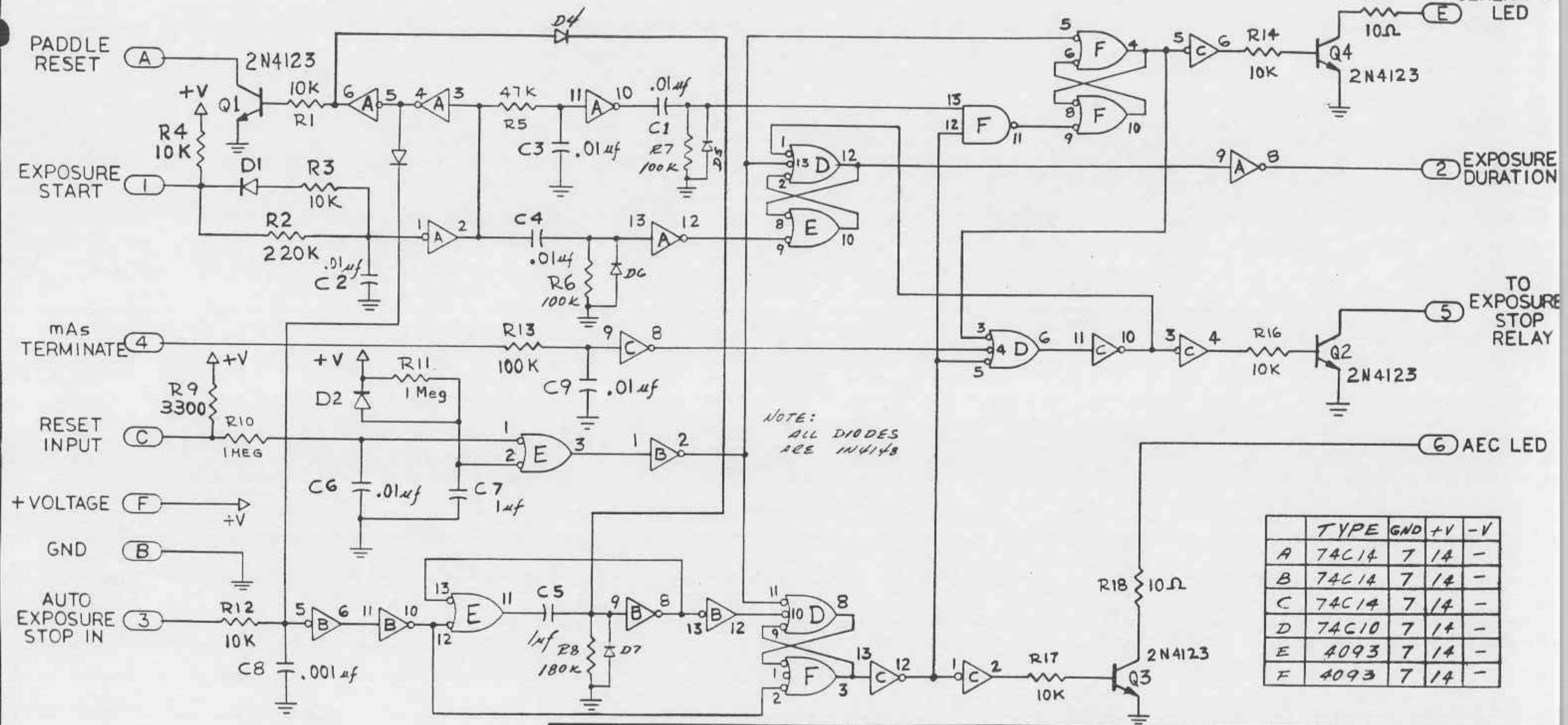
X-RAY

ADVANCED INSTRUMENT DEVELOPMENT, INC.
MELROSE PARK, ILLINOIS

INPUT AMPLIFIER AND
kVP ADJUST POTS.

DRAWN BY
CHECKED BY
APPROVED BY
NEXT ASSEMBLY
USED ON C1300 – A3300
DRAWING NO. S60899B

Figure 7.1 S60899B Input Amplifier Board


PADDLE RESET
A
2N4123
Q1
+V
R4
10K
10K
R1
D1
EXPOSURE START
1
R3
10K
R2
220K
.01uf
C2
D4
47K
R5
C3
.01uf
.01uf
C1
R7
100K
C4
.01uf
R6
100K
D6
mAs TERMINATE
4
+V
R9
3300
R13
100K
C9
.01uf
+V
R11
1 Meg
D2
RESET INPUT
C
R10
1MEG
C6
.01uf
C7
1uf
+VOLTAGE
F
+V
GND
B
AUTO EXPOSURE STOP IN
3
R12
10K
C8
.001uf
C5
1uf
R8
180K
D7
NOTE: ALL DIODES ARE IN4148
R15
10Ω
GENERATOR LED
E
R14
10K
Q4
2N4123
EXPOSURE DURATION
2
TO EXPOSURE STOP RELAY
5
R16
10K
Q2
2N4123
AEC LED
6
R18
10Ω
R17
10K
2N4123
Q3

	TYPE	GND	+V	-V
A	74C14	7	14	–
B	74C14	7	14	–
C	74C14	7	14	–
D	74C10	7	14	–
E	4093	7	14	–
F	4093	7	14	–

ECN# 721 08/21/89
ECN# 716 05/15/89
2) ECN# 659 02/14/89
1) ECN# 343 5/18/84

REVISIONS

SCALE

UNLESS OTHERWISE SPECIFIED:

FRACTIONS	DECIMALS	ANGLES
± 1/64	.xx ± .010 .xxx ± .005	± 1°

MATERIAL

FINISH

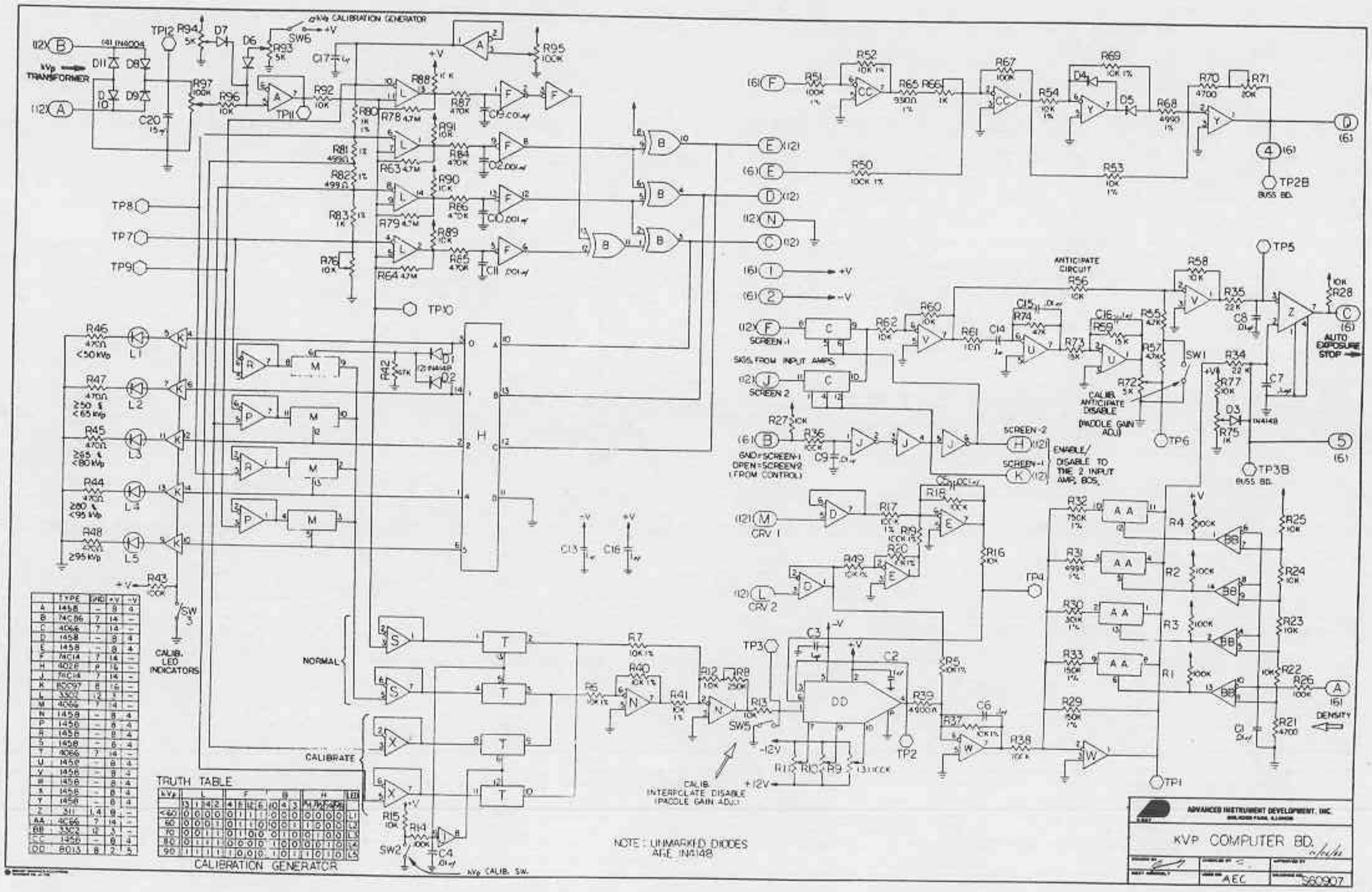
X-RAY

ADVANCED INSTRUMENT DEVELOPMENT, INC.
MELROSE PARK, ILLINOIS

LOGIC CONTROL BD.

DRAWN BY	CHECKED BY	APPROVED BY
NEXT ASSEMBLY	USED ON A3365	DRAWING NO. S 60900

Figure 7.2 S60900F Logic Control Board


kVp CALIBRATION GENERATOR
kVp TRANSFORMER
TP12
TP11
TP10
TP8
TP7
TP9
TP5
TP6
TP4
TP3
TP2
TP1
TP2B
BUSS BD.
TP3B
BUSS BD.
SW6
SW1
SW2
SW5
R46 470Ω <50 kVp L1
R47 470Ω ≥50 & <65 kVp L2
R45 470Ω ≥65 & <80 kVp L3
R44 470Ω ≥80 & <95 kVp L4
R48 470Ω ≥95 kVp L5
CALIB. LED INDICATORS
NORMAL
CALIBRATE
ANTICIPATE CIRCUIT
CALIB. ANTICIPATE DISABLE (PADDLE GAIN ADJ.)
SCREEN-1
SCREEN 2
SIGS. FROM INPUT AMPS.
GND=SCREEN-1 OPEN=SCREEN-2 (FROM CONTROL)
SCREEN-2
SCREEN-1
ENABLE/ DISABLE TO THE 2 INPUT AMP. BDS.
CRV 1
CRV 2
AUTO EXPOSURE STOP
DENSITY
CALIB. INTERPOLATE DISABLE (PADDLE GAIN ADJ.)
kVp CALIB. SW.
NOTE: UNMARKED DIODES ARE IN4148
ADVANCED INSTRUMENT DEVELOPMENT, INC.
KVP COMPUTER BD.
AEC
S60907

	TYPE	GND	+V	-V
A	1458	–	8	4
B	74C86	7	14	–
C	4066	7	14	–
D	1458	–	8	4
E	1458	–	8	4
F	74C14	7	14	–
H	4028	8	16	–
J	74C14	7	14	–
K	80C97	8	16	–
L	3302	12	3	–
M	4066	7	14	–
N	1458	–	8	4
P	1458	–	8	4
R	1458	–	8	4
S	1458	–	8	4
T	4066	7	14	–
U	1458	–	8	4
V	1458	–	8	4
W	1458	–	8	4
X	1458	–	8	4
Y	1458	–	8	4
Z	311	1,4	8	–
AA	4066	7	14	–
BB	3302	12	3	–
CC	1458	–	8	4
DD	8013	8	2	5

TRUTH TABLE

kVp	L				F				B			H				LED
	13	1	14	2	4	5	12	6	10	4	3	[illegible]	[illegible]	[illegible]	[illegible]	
<60	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	L1
60	0	0	0	1	0	1	1	0	0	0	1	1	0	0	0	L2
70	0	0	1	1	0	1	0	0	0	1	0	0	1	0	0	L3
80	0	1	1	1	0	0	0	0	1	0	0	0	0	1	0	L4
90	1	1	1	1	1	0	0	0	1	0	1	1	0	1	0	L5

CALIBRATION GENERATOR

Figure 7.3 S60907D kVp Computer Board

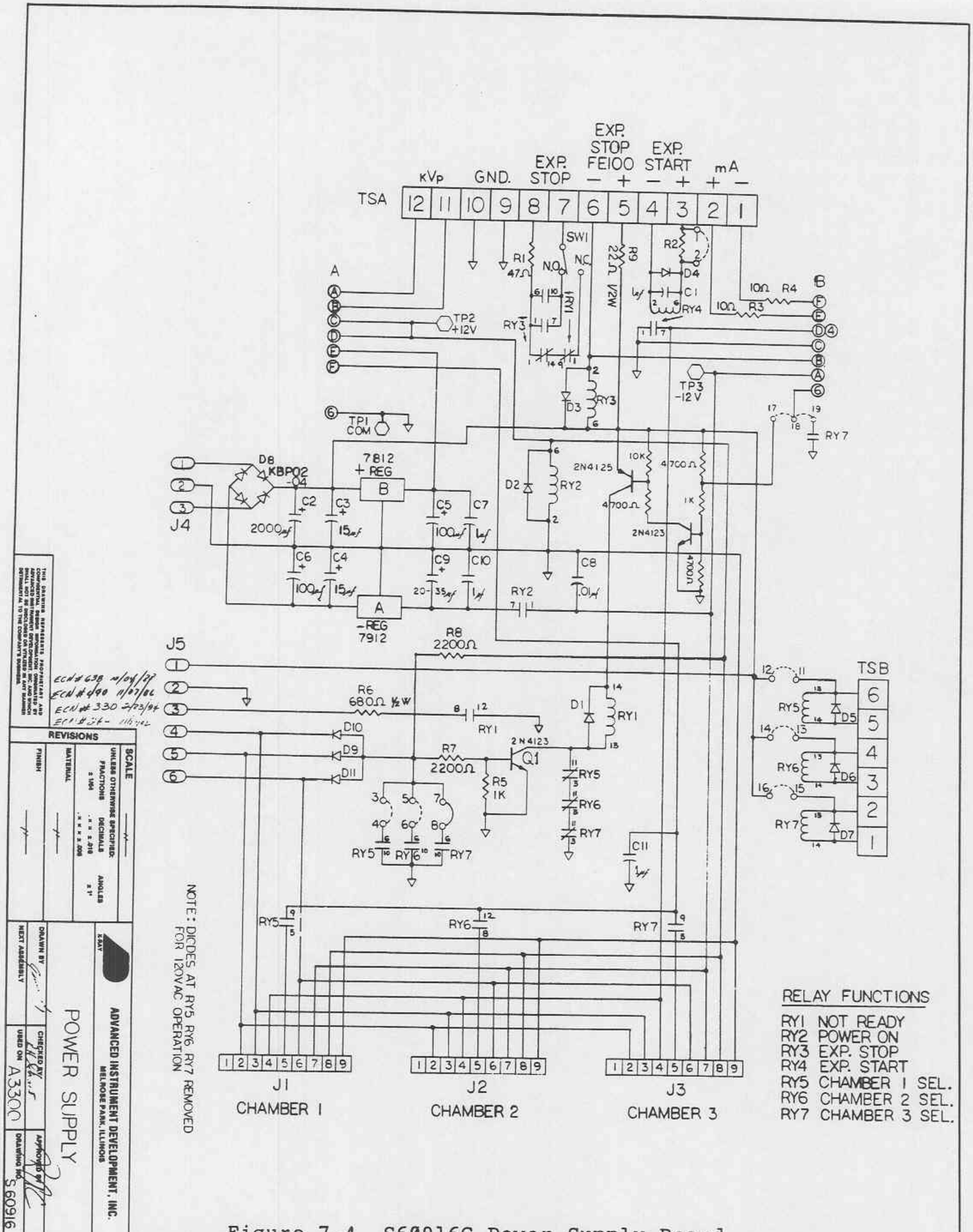

TSA
KVp
GND.
EXP. STOP
EXP. STOP FE100
EXP. START
mA
12 11 10 9 8 7 6 5 4 3 2 1
SW1
N.O.
N.C.
R1 47Ω
R9 22Ω 1/2W
R2
D4
C1
RY4
R4 10Ω
R3 10Ω
RY1
RY3
TP2 +12V
TP3 -12V
D3
RY7
TP1 COM
D8 KBP02-04
7812 + REG
B
C2 2000
C3 15
C5 100
C7 1
J4
C6 100
C4 15
C9 20-35
C10 1
RY2
C8 .01
A
-REG 7912
D2
2N4125
10K
4700Ω
1K
2N4123
J5
R8 2200Ω
R6 680Ω 1/2W
D10
D9
D11
R7 2200Ω
2N4123
Q1
R5 1K
D1
RY5
RY6
RY7
C11 1
TSB
D5
D6
D7
J1 CHAMBER 1
J2 CHAMBER 2
J3 CHAMBER 3
RELAY FUNCTIONS
RY1 NOT READY
RY2 POWER ON
RY3 EXP. STOP
RY4 EXP. START
RY5 CHAMBER 1 SEL.
RY6 CHAMBER 2 SEL.
RY7 CHAMBER 3 SEL.
NOTE: DIODES AT RY5, RY6, RY7 REMOVED FOR 120VAC OPERATION
ECN #638 10/04/27
ECN #490 11/07/86
ECN #330 2/23/94
REVISIONS
SCALE
ADVANCED INSTRUMENT DEVELOPMENT, INC.
MELROSE PARK, ILLINOIS
POWER SUPPLY
DRAWN BY
CHECKED BY
APPROVED BY
NEXT ASSEMBLY
USED ON A3300
DRAWING NO. S60916

Figure 7.4 S60916C Power Supply Board

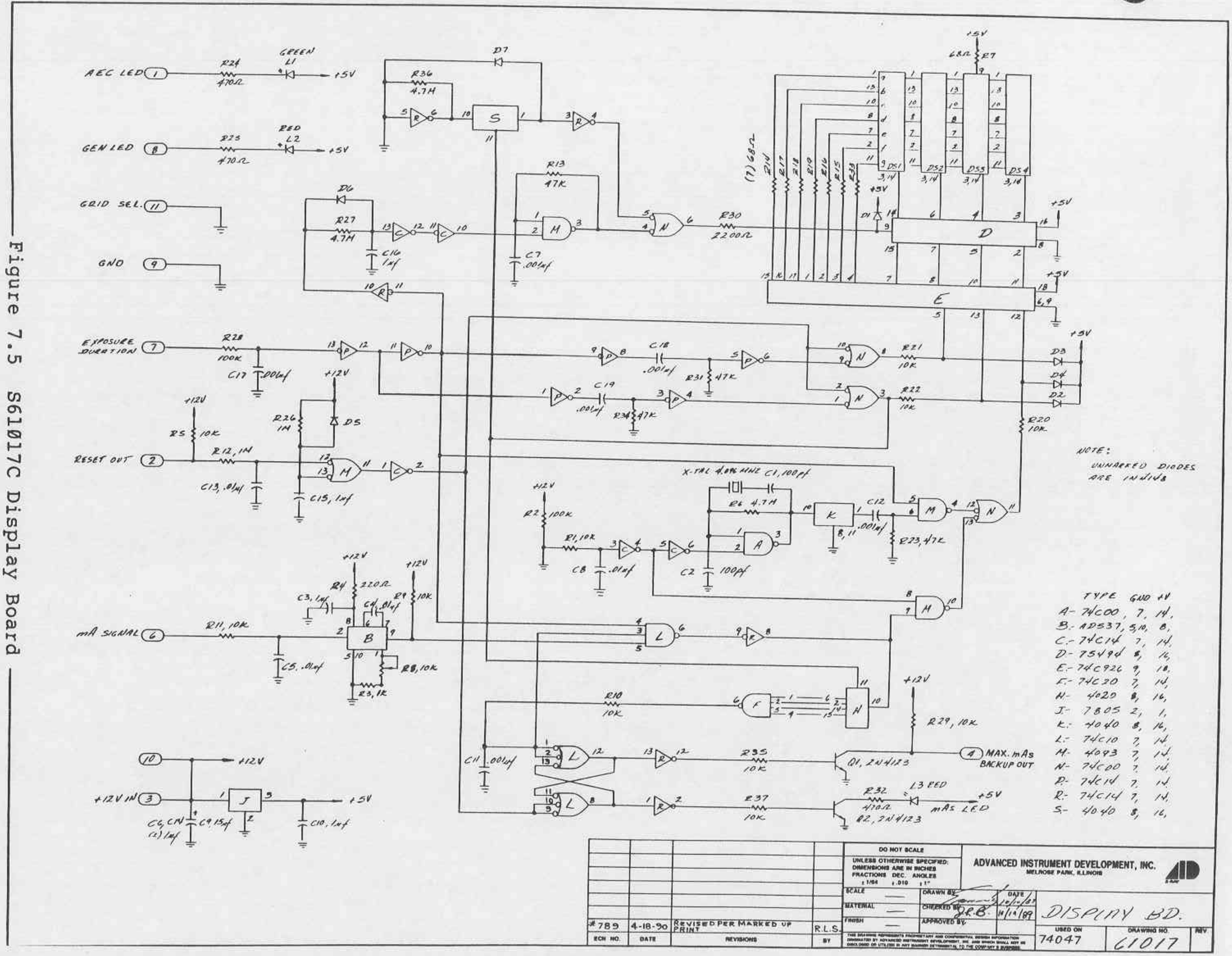

AEC LED 1
R24 470Ω
GREEN L1
+5V
GEN LED 8
R23 470Ω
RED L2
GRID SEL. 11
GND 9
EXPOSURE DURATION 7
R28 100K
C17 .001uf
RESET OUT 2
R5 10K
R12, 1M
C13, .01uf
R26 1M
D5
C15, 1uf
+12V
mA SIGNAL 6
R11, 10K
C5, .01uf
R4 220Ω
C3, 1uf
C4 .01uf
R9 10K
R8, 10K
R3, 1K
10 +12V
+12V IN 3
J
C6, C14 (2) 1uf
C9 15uf
C10, 1uf
+5V
D7
R36 4.7M
S
D6
R27 4.7M
C16 1uf
R13 47K
M
C7 .001uf
N
R30 2200Ω
(7) 68Ω
R14 R17 R18 R19 R16 R15 R33
DS1 DS2 DS3 DS4
R7 68Ω
D
E
D1
C18 .001uf
R31 47K
C19 .001uf
R34 47K
R21 10K
R22 10K
D3 D4 D2
R20 10K
NOTE: UNMARKED DIODES ARE IN4148
X-TAL 4.096 MHZ
C1, 100pf
R6 4.7M
K
C12 .001uf
R23, 47K
R2 100K
R1, 10K
C8 .01uf
A
C2 100pf
L
F
H
R10 10K
C11 .001uf
R29, 10K
R35 10K
Q1, 2N4123
4 MAX. mAs BACKUP OUT
R37 10K
R32 470Ω
L3 RED
mAs LED
Q2, 2N4123
TYPE GND +V
A- 74C00, 7, 14,
B.- AD537, 5,10, 8,
C.- 74C14 7, 14,
D- 75494 8, 16,
E.- 74C926 9, 18,
F.- 74C20 7, 14,
H- 4020 8, 16,
J.- 7805 2, 1,
K.- 4040 8, 16,
L.- 74C10 7, 14,
M- 4093 7, 14,
N- 74C00 7, 14,
P.- 74C14 7, 14,
R.- 74C14 7, 14,
S.- 4040 8, 16,
#789 4-18-90 REVISED PER MARKED UP PRINT R.L.S.
ECN NO. DATE REVISIONS BY
DO NOT SCALE
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES
FRACTIONS ±1/64 DEC. ±.010 ANGLES ±1°
SCALE
MATERIAL
FINISH
DRAWN BY
DATE 10/10/89
CHECKED BY J.R.B. 10/19/89
APPROVED BY
ADVANCED INSTRUMENT DEVELOPMENT, INC.
MELROSE PARK, ILLINOIS
DISPLAY BD.
USED ON 74047
DRAWING NO. 61017
REV

Figure 7.5 S61017C Display Board

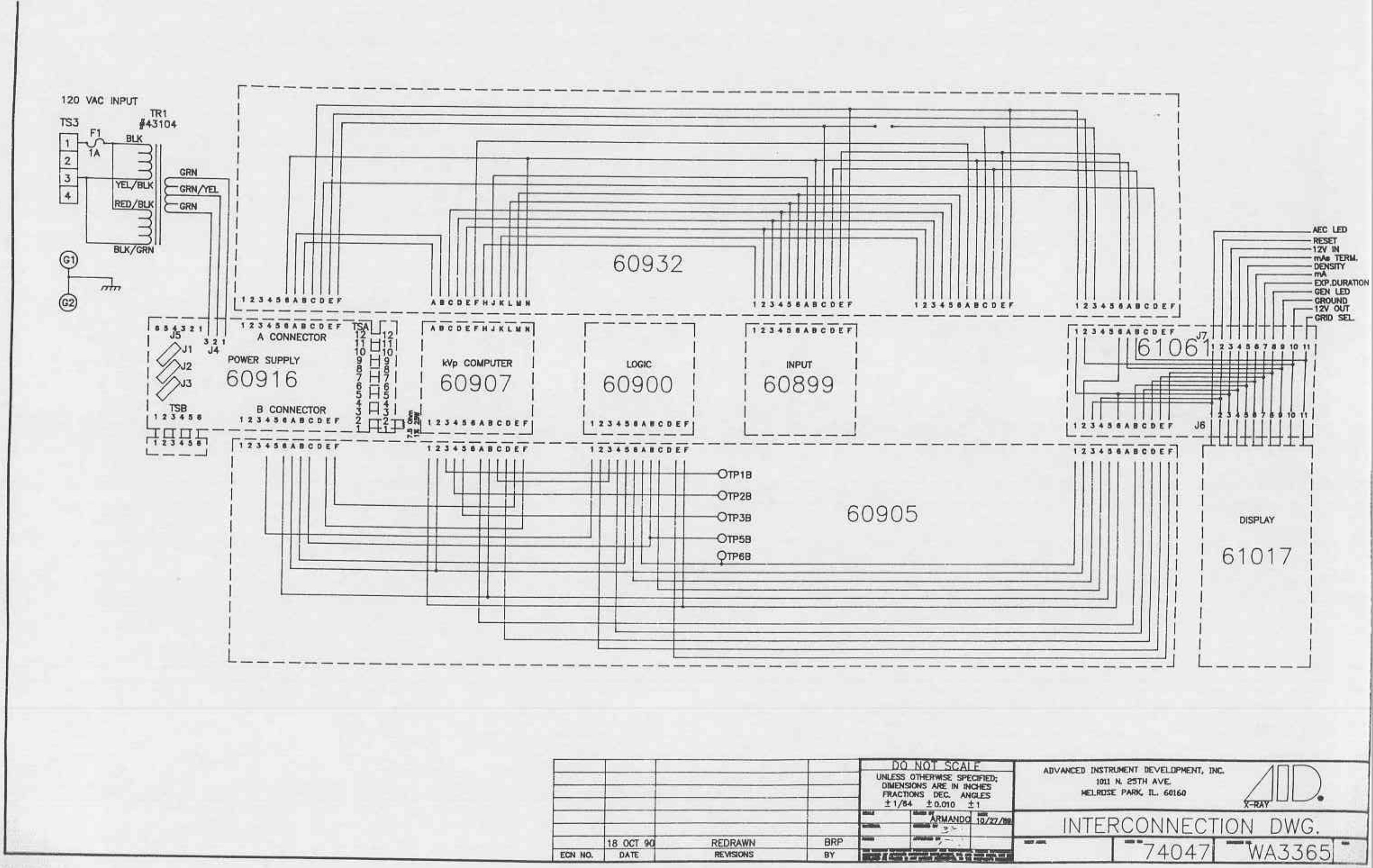
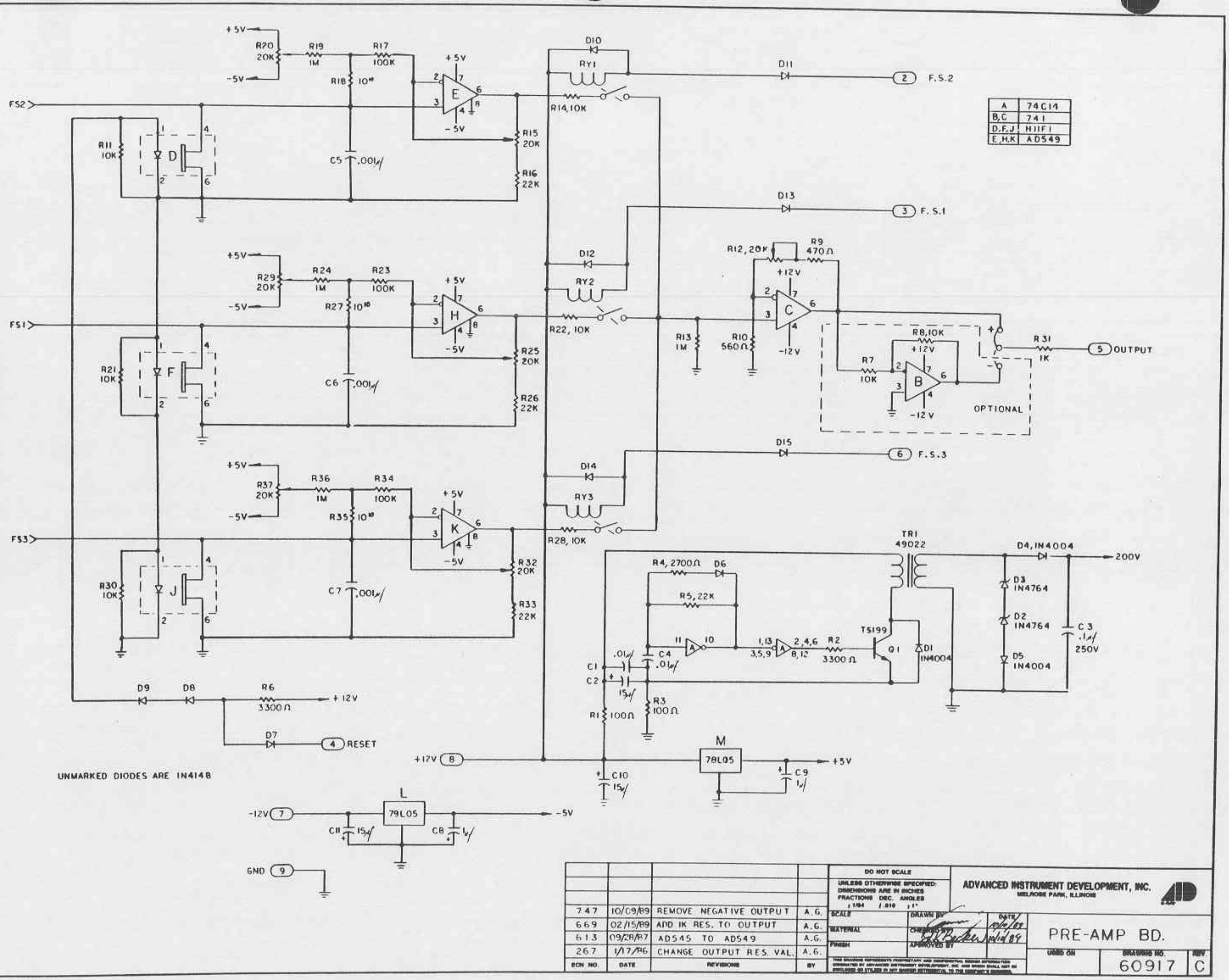
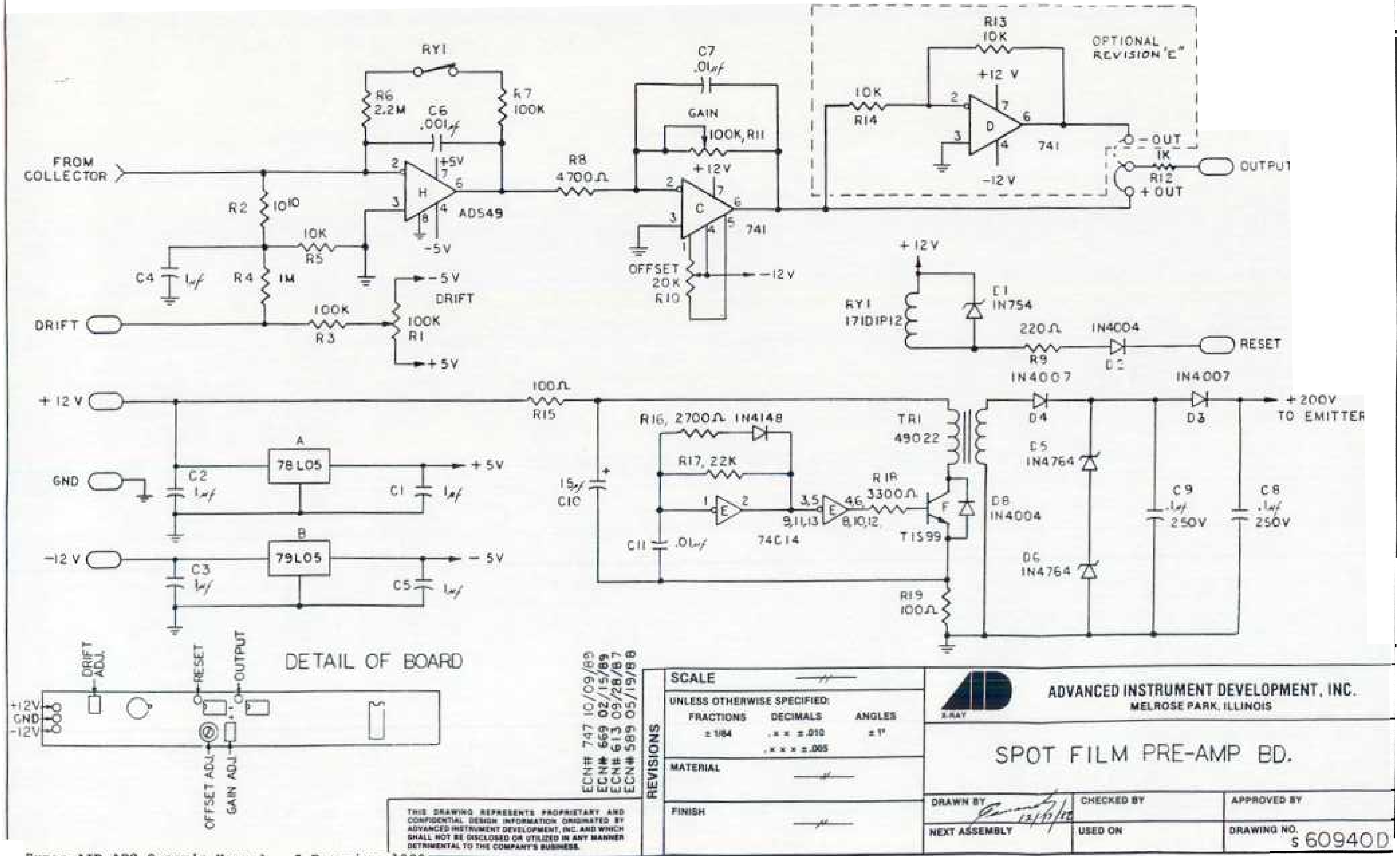

120 VAC INPUT
TS3
TR1
#43104
F1
1A
BLK
YEL/BLK
RED/BLK
BLK/GRN
GRN
GRN/YEL
GRN
G1
G2
60932
J5
J4
J1
J2
J3
A CONNECTOR
POWER SUPPLY
60916
B CONNECTOR
TSB
TSA
7.5 Ohm 1K 25W
kVp COMPUTER
60907
LOGIC
60900
INPUT
60899
61061
J7
J8
AEC LED
RESET
12V IN
mAs TERM.
DENSITY
mA
EXP.DURATION
GEN LED
GROUND
12V OUT
GRID SEL.
60905
TP1B
TP2B
TP3B
TP5B
TP6B
DISPLAY
61017
18 OCT 90
REDRAWN
BRP
ECN NO.
DATE
REVISIONS
BY
DO NOT SCALE
UNLESS OTHERWISE SPECIFIED;
DIMENSIONS ARE IN INCHES
FRACTIONS DEC. ANGLES
±1/64 ±0.010 ±1
ARMANDO
10/27/89
ADVANCED INSTRUMENT DEVELOPMENT, INC.
1011 N. 25TH AVE.
MELROSE PARK, IL. 60160
AID
X-RAY
INTERCONNECTION DWG.
74047
WA3365

Figure 7.6 WA3365A Interconnection Drawing


+5V
R20 20K
-5V
R19 1M
R17 100K
R18 10¹⁰
C5 .001µf
+5V
E
-5V
R15 20K
R16 22K
FS2
R11 10K
D
D10
RY1
R14,10K
D11
2 F.S.2
A 74C14
B,C 741
D,F,J, H11F1
E,H,K AD549
D13
3 F.S.1
D12
RY2
R22, 10K
R12, 20K
R9 470Ω
+12V
C
-12V
R13 1M
R10 560Ω
R8,10K
+12V
R7 10K
B
-12V
OPTIONAL
R31 1K
5 OUTPUT
+5V
R29 20K
-5V
R24 1M
R23 100K
R27 10¹⁰
C6 .001µf
H
R25 20K
R26 22K
FS1
R21 10K
F
D15
6 F.S.3
D14
RY3
R28, 10K
+5V
R37 20K
-5V
R36 1M
R34 100K
R35 10¹⁰
C7 .001µf
K
R32 20K
R33 22K
FS3
R30 10K
J
TR1 49022
D4, 1N4004
200V
R4, 2700Ω
D6
R5, 22K
D3 1N4764
D2 1N4764
D5 1N4004
C3 .1µf 250V
T5199
Q1
D1 1N4004
C1 .01µf
C4 .01µf
C2 15µf
R2 3300Ω
R3 100Ω
R1 100Ω
D9
D8
R6 3300Ω
+12V
D7
4 RESET
+12V 8
M
78L05
+5V
C10 15µf
C9 1µf
UNMARKED DIODES ARE 1N4148
L
-12V 7
79L05
-5V
C11 15µf
C8 1µf
GND 9
DO NOT SCALE
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES
FRACTIONS ±1/64 DEC. ±.010 ANGLES ±1°
ADVANCED INSTRUMENT DEVELOPMENT, INC.
MELROSE PARK, ILLINOIS
SCALE
MATERIAL
FINISH
DRAWN BY
CHECKED BY
APPROVED BY
DATE
PRE-AMP BD.
USED ON
DRAWING NO. 60917
REV. C

ECN NO.	DATE	REVISIONS	BY
747	10/09/89	REMOVE NEGATIVE OUTPUT	A.G.
669	02/15/89	ADD 1K RES. TO OUTPUT	A.G.
613	09/28/87	AD545 TO AD549	A.G.
267	1/17/86	CHANGE OUTPUT RES. VAL.	A.G.

Figure 7.7 S60917C Three Field Preamplifier


RY1
R6
2.2M
C6
.001µf
R7
100K
FROM
COLLECTOR
R2
10^10
2
3
H
+5V
7
6
8
4
AD549
-5V
10K
R5
C4
1µf
R4
1M
-5V
DRIFT
DRIFT
100K
R3
100K
R1
+5V
R8
4700Ω
C7
.01µf
GAIN
100K, R11
+12V
2
3
C
7
6
5
4
1
741
OFFSET
20K
R10
-12V
R13
10K
OPTIONAL
REVISION 'E'
+12 V
10K
R14
2
3
D
7
6
4
741
-12 V
- OUT
1K
R12
+ OUT
OUTPUT
+12V
RY1
171D1P12
E1
1N754
220Ω
R9
1N4004
D2
RESET
+12 V
100Ω
R15
1N4007
D4
1N4007
D3
+200V
TO EMITTER
GND
-12 V
A
78L05
+5V
C2
1µf
C1
1µf
B
79L05
-5V
C3
1µf
C5
1µf
15µf
C10
R16, 2700Ω
1N4148
R17, 22K
1
E
2
3,5
E
4,6
9,11,13
8,10,12
74C14
C11
.01µf
R18
3300Ω
F
TIS99
TR1
49022
D8
1N4004
D5
1N4764
D6
1N4764
C9
.1µf
250V
C8
.1µf
250V
R19
100Ω
DETAIL OF BOARD
DRIFT ADJ.
RESET
OUTPUT
+12V
GND
-12V
OFFSET ADJ.
GAIN ADJ.
ECN# 747 10/09/89
ECN# 669 02/15/89
ECN# 613 09/28/87
ECN# 589 05/19/88
REVISIONS
SCALE
UNLESS OTHERWISE SPECIFIED:
FRACTIONS ±1/64
DECIMALS .x x ±.010 .x x x ±.005
ANGLES ±1°
MATERIAL
FINISH
X-RAY
ADVANCED INSTRUMENT DEVELOPMENT, INC.
MELROSE PARK, ILLINOIS
SPOT FILM PRE-AMP BD.
DRAWN BY
12/17/82
CHECKED BY
APPROVED BY
NEXT ASSEMBLY
USED ON
DRAWING NO.
S 60940D

THIS DRAWING REPRESENTS PROPRIETARY AND CONFIDENTIAL DESIGN INFORMATION ORIGINATED BY ADVANCED INSTRUMENT DEVELOPMENT, INC. AND WHICH SHALL NOT BE DISCLOSED OR UTILIZED IN ANY MANNER DETRIMENTAL TO THE COMPANY'S BUSINESS.

Figure 7.8 S60940D Single Field Preamplifier

Figure 7.9
60899B Input Amplifier Board

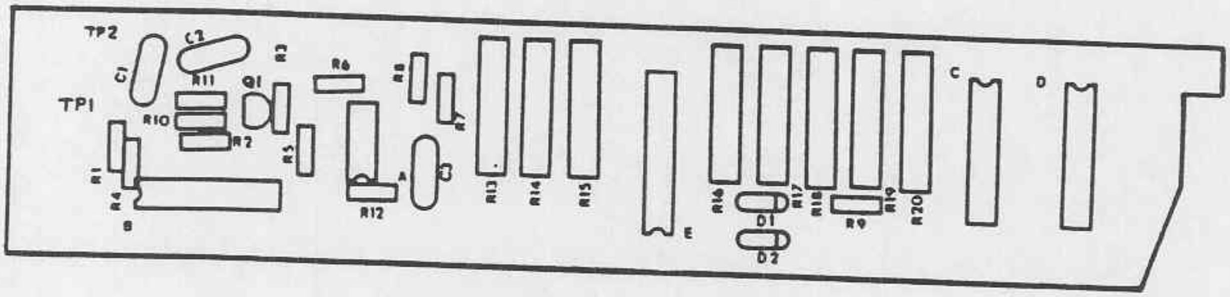

TP2
C2
R3
R6
R8
C1
R11
Q1
TP1
R10
R2
R5
R7
R1
R4
B
A
C3
R12
R13
R14
R15
E
R16
D1
R17
R18
R19
R9
R20
D2
C
D

Figure 7.10
60900F Logic Control Board

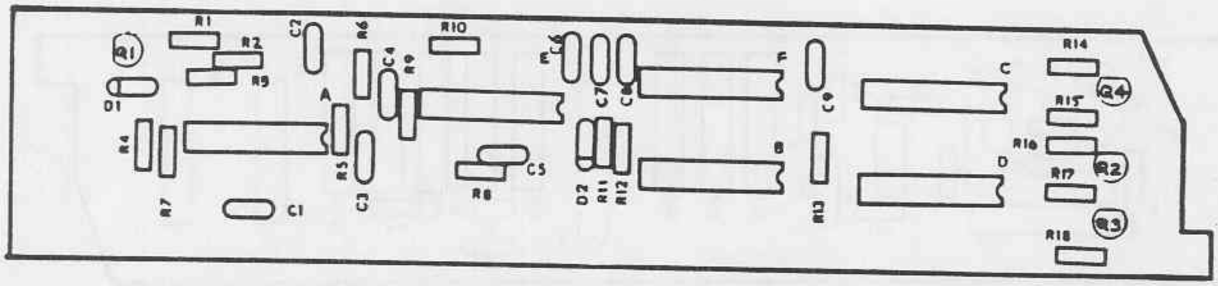

R1
Q1
R2
R3
D1
R4
R7
C1
C2
R6
A
R5
C3
C4
R9
R10
C5
R8
E
C6
C7
C8
D2
R11
R12
F
B
C9
R13
C
D
R14
Q4
R15
R16
Q2
R17
Q3
R18

Figure 7.11
60907D kVp Computer Board

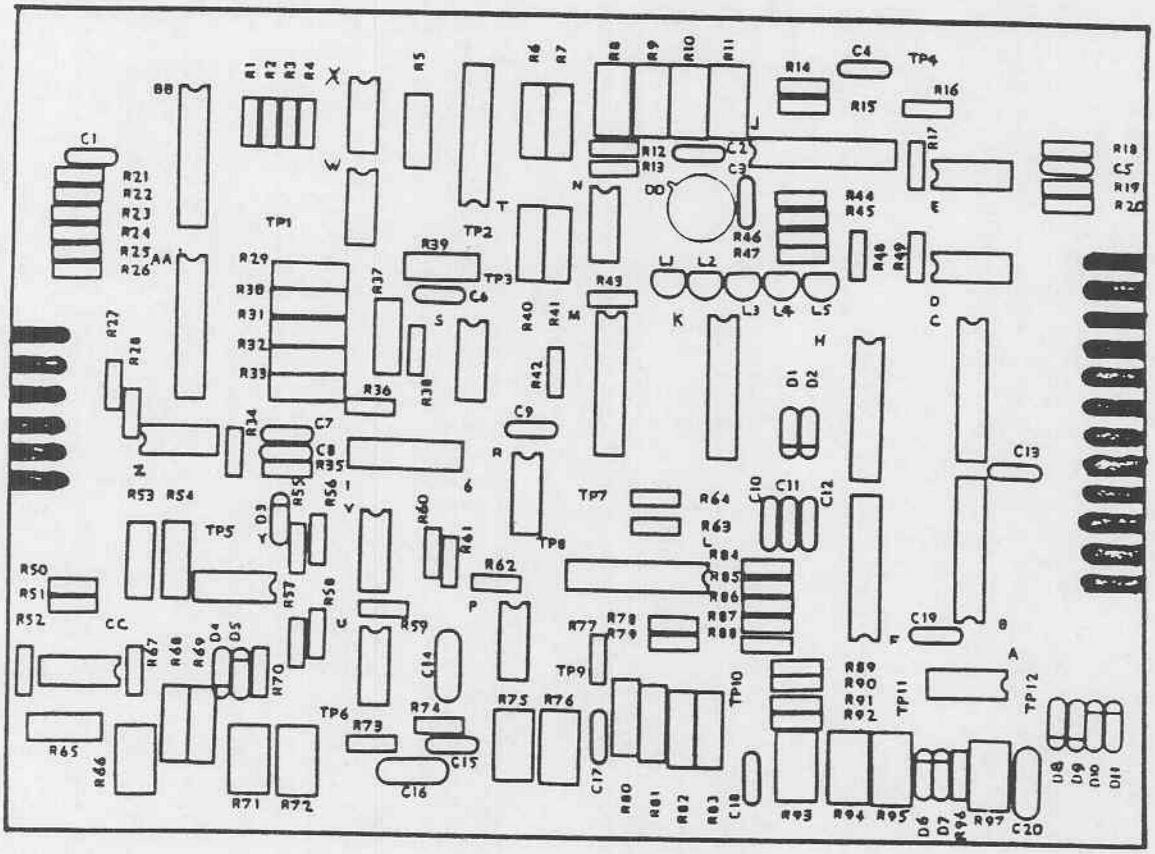
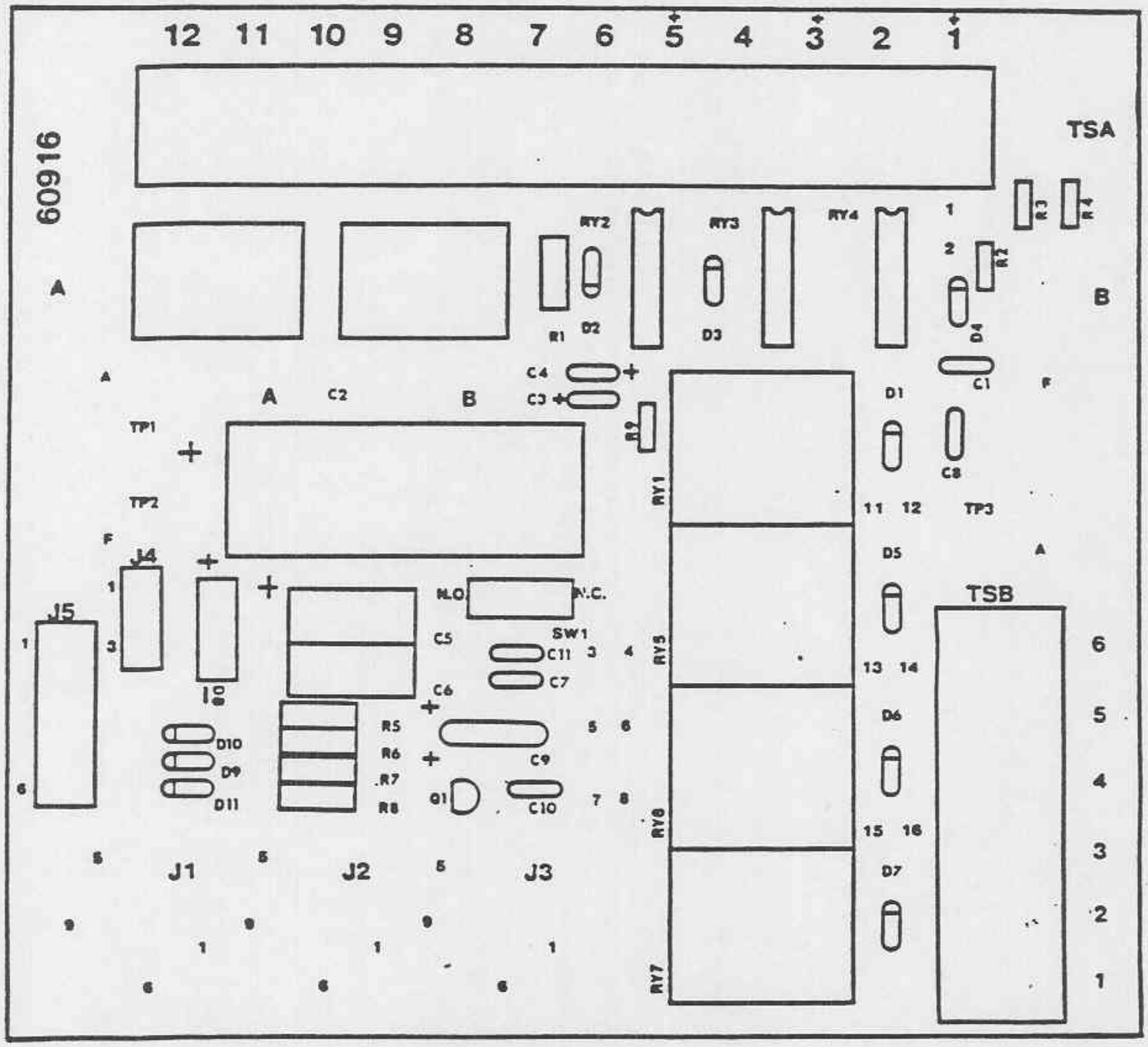

C1
R21
R22
R23
R24
R25
R26
BB
AA
R1
R2
R3
R4
X
W
R5
T
TP1
TP2
R6
R7
R8
R9
R10
R11
R12
R13
C2
C3
DD
N
J
R14
C4
TP4
R15
R16
R17
R18
C5
R19
R20
E
R44
R45
R46
R47
R48
R49
D
C
L1
L2
L3
L4
L5
K
H
R29
R30
R31
R32
R33
R36
R37
R38
R39
TP3
C6
S
R40
R41
M
R42
R43
R27
R28
R34
C7
C8
R35
Z
C9
R
D1
D2
C10
C11
C12
C13
TP7
R64
R63
TP8
R53
R54
TP5
D3
Y
R55
R56
I
V
6
R60
R61
R62
P
R84
R85
R86
R87
R88
R50
R51
R52
CC
R57
R58
U
R59
C14
R77
R78
R79
TP9
C19
F
B
A
R67
R68
R69
D4
D5
R70
TP6
R73
R74
C15
C16
R75
R76
C17
R80
R81
R82
R83
C18
TP10
R89
R90
R91
R92
TP11
TP12
R65
R66
R71
R72
R93
R94
R95
D6
D7
R96
R97
C20
D8
D9
D10
D11

Figure 7.12
60916C Power Supply Board


12
11
10
9
8
7
6
5
4
3
2
1
TSA
60916
A
B
RY2
RY3
RY4
R1
D2
D3
R3
R4
R2
D4
C4
C3
C2
C1
R9
D1
C8
TP1
TP2
TP3
RY1
11 12
D5
F
J4
J5
TSB
N.O.
N.C.
SW1
C5
C11
C7
C6
RY5
13 14
D6
R5
R6
R7
R8
C9
C10
Q1
D10
D9
D11
RY6
15 16
D7
J1
J2
J3
RY7
6
5
4
3
2
1

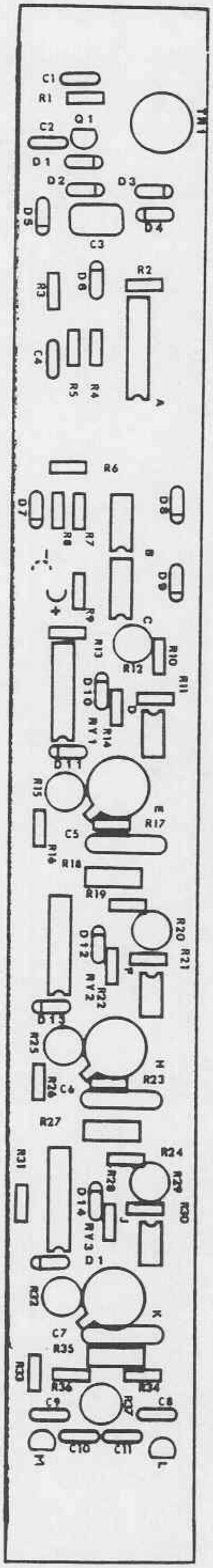

C1
R1
VM1
C2
Q1
D1
D2
D3
D5
D4
C3
R2
R3
D6
C4
R5
R4
A
R6
D7
R8
R7
D8
B
D9
+
R9
R13
C
R10
R12
R11
D10
RY1
R14
D
D11
R15
E
R17
C5
R16
R18
R19
R20
D12
R21
RY2
R22
F
D13
R25
H
R26
C6
R23
R27
R31
R24
R28
R29
D14
R30
RY3
J
D1
R32
K
C7
R35
R33
R36
R34
C9
R37
C8
C10
C11
M
L

Figure 7.13
60917C
Three Field Preamplifier

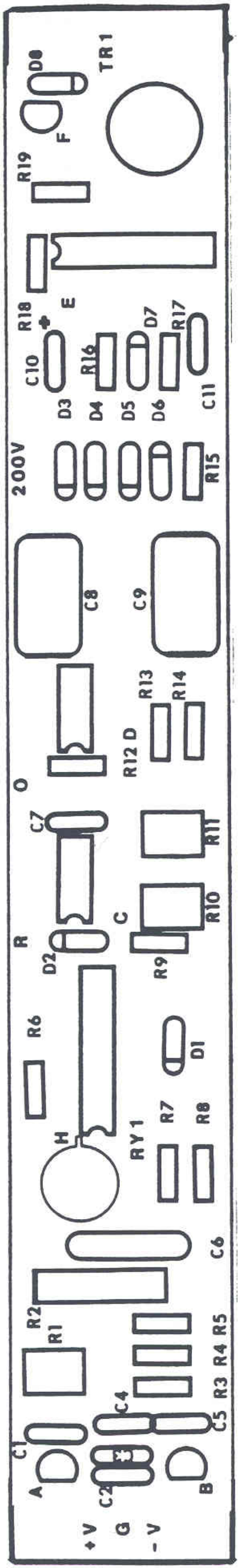

TR1
D8
F
R19
R18
E
D7
R17
C10
R16
D3
D4
D5
D6
C11
200V
R15
C8
C9
R13
R14
R12 D
O
C7
R11
R10
C
R
D2
R9
R6
D1
H
RY1
R7
R8
C6
R2
R1
R3 R4 R5
C4
C5
C1
A
C2
B
+V G -V

Figure 7.14
60940D
Single Field Preamplifier

Figure 7.15
61017C
Internal Display Board

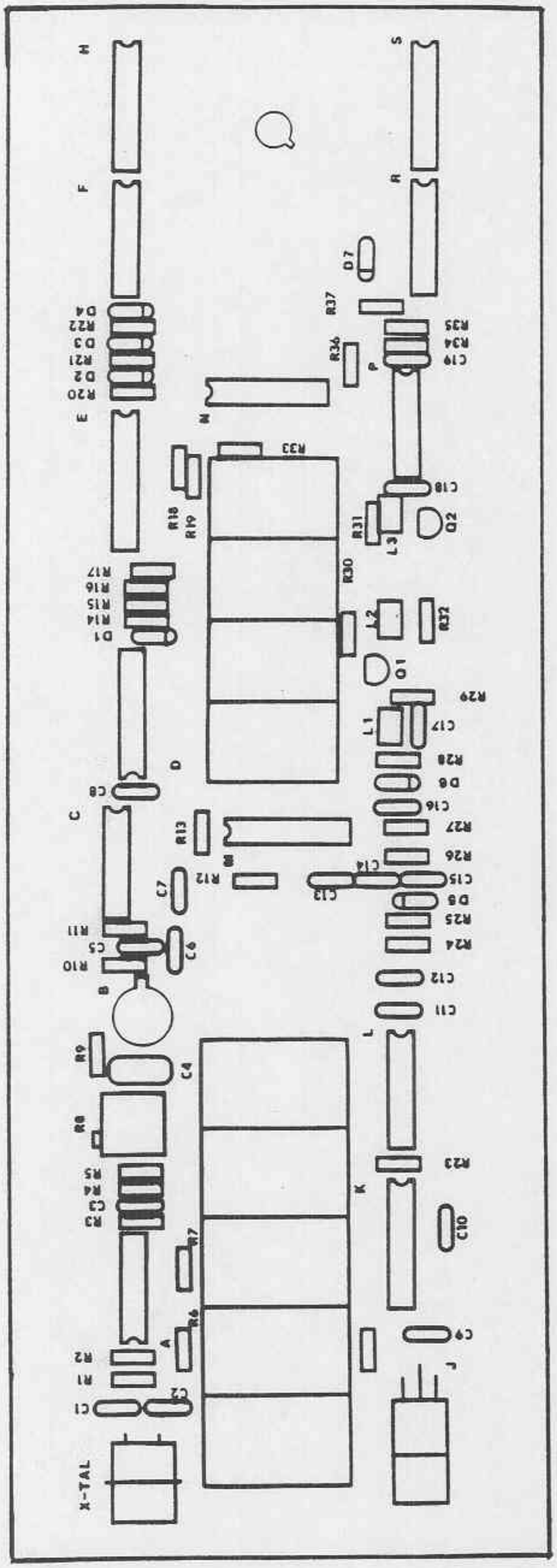
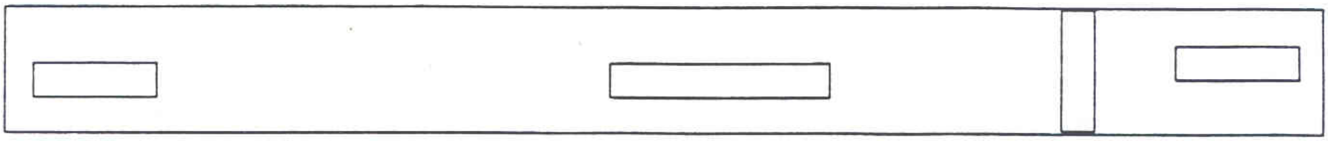
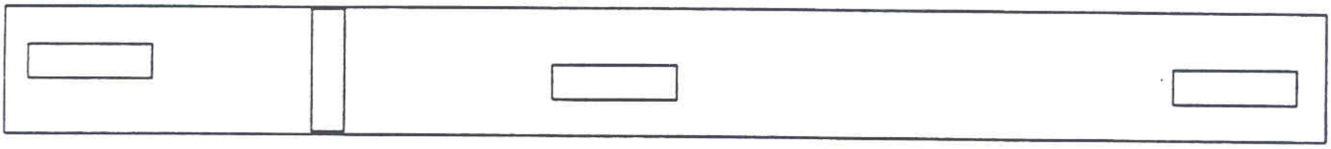

H
F
R20
D2
R21
D3
R22
D4
E
R17
R16
R15
R14
D1
D
C8
C
R11
C5
R10
B
R9
C4
R8
R5
R4
C3
R3
R7
R6
A
R2
R1
C1
C2
X-TAL
R18
R19
R33
N
R13
M
R12
C7
C6
K
S
R
D7
R37
R35
R34
C19
R36
P
C18
Q2
R31
L3
R30
L2
R32
Q1
R29
L1
C17
R28
D6
C16
R27
R26
C14
C15
C13
D5
R25
R24
C12
C11
L
R23
C10
C9
J

Figure 7.16



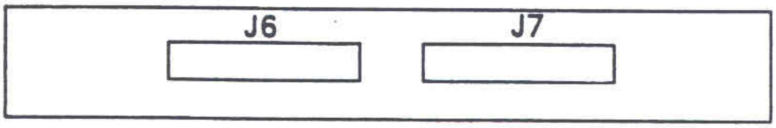
Component Location Diagram Top Bus Board 60932C

Figure 7.17



Component Location Diagram Bottom Bus Board 60905 D

Figure 7.18



Component Location Diagram Display Connector Board 61061A

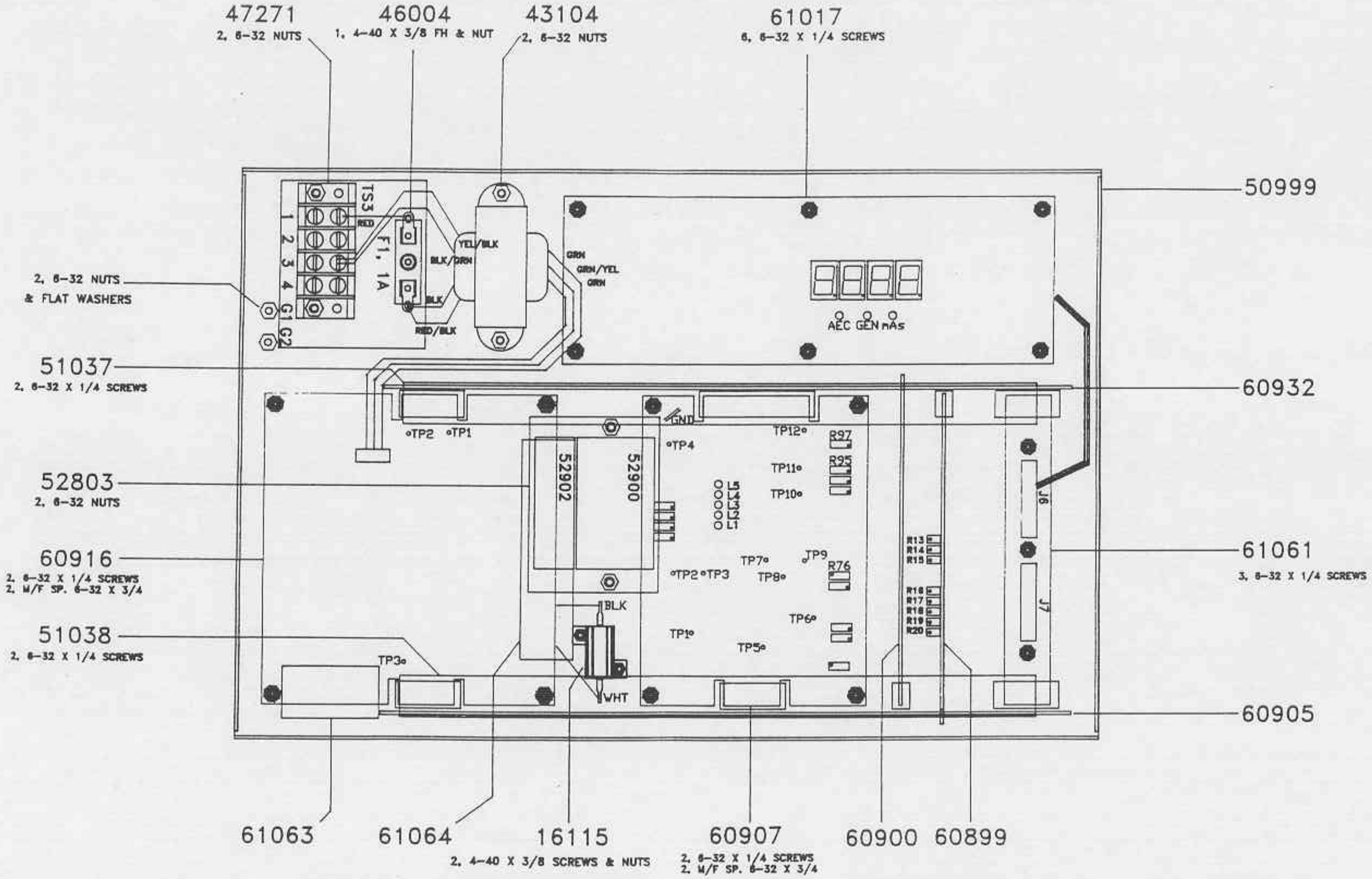

47271
2, 6-32 NUTS
46004
1, 4-40 X 3/8 FH & NUT
43104
2, 6-32 NUTS
61017
6, 6-32 X 1/4 SCREWS
50999
2, 6-32 NUTS
& FLAT WASHERS
TS3
1
2
3
4
G1
G2
RED
F1, 1A
YEL/BLK
BLK/GRN
BLK
RED/BLK
GRN
GRN/YEL
GRN
AEC GEN mAs
51037
2, 6-32 X 1/4 SCREWS
60932
GND
TP2
TP1
TP4
TP12
R97
R95
TP11
TP10
52803
2, 6-32 NUTS
52902
52900
L5
L4
L3
L2
L1
J6
R13
R14
R15
60916
2, 6-32 X 1/4 SCREWS
2, M/F SP. 6-32 X 3/4
TP7
TP9
R76
TP2
TP3
TP8
61061
3, 6-32 X 1/4 SCREWS
R16
R17
R18
R19
R20
J7
BLK
TP6
TP1
TP5
51038
2, 6-32 X 1/4 SCREWS
TP3
WHT
60905
61063
61064
16115
2, 4-40 X 3/8 SCREWS & NUTS
60907
2, 6-32 X 1/4 SCREWS
2, M/F SP. 6-32 X 3/4
60900
60899

Figure 7.19
74047A
Expos-AID A3365 Assembly

SEE ADJACENT FOLDOUT FOR THIS PAGE.

TABLE 7-1

PARTS LIST
60899B INPUT AMPLIFIER BOARD

RESISTORS:

R1	100 OHM 5% 1/4W
R2	4.7K OHM 5% 1/4W
R3	4.7K OHM 5% 1/4W
R4	4.7K OHM 5% 1/4W
R5	2.2K OHM 5% 1/4W
R6	3.3K OHM 5% 1/4W
R7	1.0M OHM 5% 1/4W
R8	4.7K OHM 5% 1/4W
R9	22K OHM 5% 1/4W
R10	100K OHM 5% 1/4W
R11	47K OHM 5% 1/4W
R12	10K OHM 5% 1/4W

CAPACITORS:

C1	.01 MFD 50V DISC CERAMIC
C2	.1 MFD 50V MONOLITHIC CERAMIC
C3	.01 MFD 50V DISC CERAMIC

DIODES:

D1	1N4148 150 MA 75V PRV
D2	1N4148 150 MA 75V PRV

TRANSISTORS:

Q1	2N4123 NPN GENERAL PURPOSE TO-92

IC'S:

A	LM1458N DUAL OPERATIONAL AMP
B	4066B QUAD BILATERAL SWITCH
C	4066B QUAD BILATERAL SWITCH
D	4066B QUAD BILATERAL SWITCH
E	CD4028A BCD DECIMAL DECODER

TABLE 7-2

PARTS LIST
60900F LOGIC CONTROL BOARD

RESISTORS:

R1	10K OHM 5% 1/4W
R2	220K OHM 5% 1/4W
R3	10K OHM 5% 1/4W
R4	10K OHM 5% 1/4W
R5	47K OHM 5% 1/4W
R6	100K OHM 5% 1/4W
R7	100K OHM 5% 1/4W
R8	180K OHM 5% 1/4W
R9	3.3K OHM 5% 1/4W
R10	1.0M OHM 5% 1/4W
R11	1.0M OHM 5% 1/4W
R12	10K OHM 5% 1/4W
R13	100K OHM 5% 1/4W
R14	10K OHM 5% 1/4W
R15	10 OHM 5% 1/4W
R16	10K OHM 5% 1/4W
R17	10K OHM 5% 1/4W
R18	10 OHM 5% 1/4W

CAPACITORS:

C1	.01 MFD 50V DISC CERAMIC
C2	.01 MFD 50V DISC CERAMIC
C3	.01 MFD 50V DISC CERAMIC
C4	.01 MFD 50V DISC CERAMIC
C5	1.0 MFD 35V DIPPED TANTALUM
C6	.01 MFD 50V DISC CERAMIC
C7	1.0 MFD 50V MONOLYTHIC CERAMIC
C8	.001 MFD 1KV DISK CERAMIC
C9	.01 MFD 50V DISC CERAMIC

TRANSISTORS:

Q1	2N4123 NPN GENERAL PURPOSE TO-92
Q2	2N4123 NPN GENERAL PURPOSE TO-92
Q3	2N4123 NPN GENERAL PURPOSE TO-92
Q4	2N4123 NPN GENERAL PURPOSE TO-92

DIODES:

D1	1N4148 150MA 75V PRV
D2	1N4148 150MA 75V PRV
D3	1N4148 150MA 75V PRV
D4	1N4148 150MA 75V PRV
D5	1N4148 150MA 75V PRV
D6	1N4148 150MA 75V PRV
D7	1N4148 150MA 75V PRV

IC'S:

A	74C14N HEX SCHMITT TRIGGER
B	74C14N HEX SCHMITT TRIGGER
C	74C14N HEX SCHMITT TRIGGER
D	74C10N TRIPLE 3 INPUT NAND GATE
E	4093B QUAD 2 INP NAND SCHMITT TRIGGER
F	4093B QUAD 2 INP NAND SCHMITT TRIGGER

TABLE 7-3

PARTS LIST
60907D kVp COMPUTER BOARD

RESISTORS:

R1	100K OHM 5% 1/4W
R2	100K OHM 5% 1/4W
R3	100K OHM 5% 1/4W
R4	100K OHM 5% 1/4W
R5	10.0K OHM 1%
R6	10.0K OHM 1%
R7	10.0K OHM 1%
R8	250K TOP ADJUST 20T VRN 752-208
R9	100K TOP ADJUST 20T VRN 752-208
R10	100K TOP ADJUST 20T VRN 752-208
R11	100K TOP ADJUST 20T VRN 752-208
R12	10K OHM 5% 1/4W
R13	10K OHM 5% 1/4W
R14	100K TOP ADJUST 20T VRN 752-208
R15	10K OHM 5% 1/4W
R16	10K OHM 5% 1/4W
R17	100K OHM 1%
R18	100K OHM 5% 1/4W
R19	100K OHM 1%
R20	10.0K OHM 1%
R21	4.7K OHM 5% 1/4W
R22	10K OHM 5% 1/4W
R23	10K OHM 5% 1/4W
R24	10K OHM 5% 1/4W
R25	10K OHM 5% 1/4W
R26	100K OHM 5% 1/4W
R27	10K OHM 5% 1/4W
R28	10K OHM 5% 1/4W
R29	150K OHM 1%
R30	301K OHM 1%
R31	499K OHM 1%
R32	750K OHM 1%
R33	150K OHM 1%
R34	22K OHM 5% 1/4W
R35	22K OHM 5% 1/4W
R36	100K OHM 5% 1/4W
R37	10.0K OHM 1%
R38	100K OHM 5% 1/4W
R39	4.99K OHM 1%
R40	10.0K OHM 1%
R41	10.0K OHM 1%
R42	47K OHM 5% 1/4W
R43	100K OHM 5% 1/4W
R44	470 OHM 5% 1/4W
R45	470 OHM 5% 1/4W
R46	470 OHM 5% 1/4W
R47	470 OHM 5% 1/4W
R48	470 OHM 5% 1/4W
R49	10.0K OHM 1%
R50	100K OHM 1%
R51	100K OHM 1%
R52	10.0K OHM 1%
R53	10.0K OHM 1%
R54	10.0K OHM 1%
R55	4.7K OHM 5% 1/4W
R56	10K OHM 5% 1/4W
R57	4.7K OHM 5% 1/4W
R58	10K OHM 5% 1/4W
R59	15K OHM 5% 1/4W
R60	10K OHM 5% 1/4W
R61	10 OHM 5% 1/4W
R62	10K OHM 5% 1/4W
R63	4.7M OHM 5% 1/4W
R64	4.7M OHM 5% 1/4W
R65	9.31K OHM 1%
R66	1K TOP ADJUST 20T VRN 752-208
R67	100K OHM 5% 1/4W
R68	4.99K OHM 1%
R69	10.0K OHM 1%
R70	4.7K OHM 5% 1/4W
R71	20K TOP ADJUST 20T VRN 752-208
R72	5K TOP ADJUST 20T VRN 752-208
R73	15K OHM 5% 1/4W
R74	47K OHM 5% 1/4W
R75	1K TOP ADJUST 20T VRN 752-208
R76	10K TOP ADJUST 20T VRN 752-208
R77	10K OHM 5% 1/4W
R78	4.7M OHM 5% 1/4W
R79	4.7M OHM 5% 1/4W
R80	1.0K OHM 1%

TABLE 7-3 (continued)
PARTS LIST
60907D kVp COMPUTER BOARD

RESISTORS CONTINUED:

R81	499 OHM 1%
R82	499 OHM 1%
R83	1.0K OHM 1%
R84	470K OHM 5% 1/4W
R85	470K OHM 5% 1/4W
R86	470K OHM 5% 1/4W
R87	470K OHM 5% 1/4W
R88	10K OHM 5% 1/4W
R89	10K OHM 5% 1/4W
R90	10K OHM 5% 1/4W
R91	10K OHM 5% 1/4W
R92	10K OHM 5% 1/4W
R93	5K TOP ADJUST 20T VRN 752-208
R94	5K TOP ADJUST 20T VRN 752-208
R95	100K TOP ADJUST 20T VRN 752-208
R96	10K OHM 5% 1/4W
R97	100K OHM 5% 1/4W

CAPACITORS:

C1	.01 MFD 50V DISC CERAMIC
C2	1.0 MFD 50V MONOLYTHIC CERAMIC
C3	1.0 MFD 50V MONOLYTHIC CERAMIC
C4	.01 MFD 50V DISC CERAMIC
C5	.001 MFD 50V DISC CERAMIC TC=Y5F
C6	0.1 MFD 50V MONOLYTHIC CERAMIC
C7	0.1 MFD 50V MONOLYTHIC CERAMIC
C8	.01 MFD 50V DISC CERAMIC
C9	.01 MFD 50V DISC CERAMIC
C10	.001 MFD 50V DISC CERAMIC TC=Y5F
C11	.001 MFD 50V DISC CERAMIC TC=Y5F
C12	.001 MFD 50V DISC CERAMIC TC=Y5F
C13	1.0 MFD 50V MONOLYTHIC CERAMIC
C14	0.1 MFD 50V MONOLYTHIC CERAMIC
C15	.01 MFD 50V DISC CERAMIC
C16	0.1 MFD 50V MONOLYTHIC CERAMIC
C17	1.0 MFD 50V MONOLYTHIC CERAMIC
C18	1.0 MFD 50V MONOLYTHIC CERAMIC
C19	.001 MFD 50V DISC CERAMIC TC=Y5F
C20	15 MFD 25V DIPPED TANTALUM

DIODES:

D1	1N4148 150MA 75V PRV
D2	1N4148 150MA 75V PRV
D3	1N4148 150MA 75V PRV
D4	1N4148 150MA 75V PRV
D5	1N4148 150MA 75V PRV
D6	1N4148 150MA 75V PRV
D7	1N4148 150MA 75V PRV
D8	1N4004 1 AMP 400V PRV
D9	1N4004 1 AMP 400V PRV
D10	1N4004 1 AMP 400V PRV
D11	1N4004 1 AMP 400V PRV

IC'S:

A	LM1458N DUAL OPERATIONAL AMP
B	74C86N QUAD 2 INPUT EXCL OR GATE
C	4066B QUAD BILATERAL SWITCH
D	LM1458N DUAL OPERATIONAL AMP
E	LM1458N DUAL OPERATIONAL AMP
F	74C14N HEX SCHMITT TRIGGER
H	CD4028A BCD DECIMAL DECODER
J	74C14N HEX SCHMITT TRIGGER
K	80C97 TRI STATE HEX BUFFER
L	LM3302N QUAD COMPARATOR
M	4066B QUAD BILATERAL SWITCH
N	LM1458N DUAL OPERATIONAL AMP
P	LM1458N DUAL OPERATIONAL AMP
R	LM1458N DUAL OPERATIONAL AMP
S	LM1458N DUAL OPERATIONAL AMP
T	4066B QUAD BILATERAL SWITCH
U	LM1458N DUAL OPERATIONAL AMP
V	LM1458N DUAL OPERATIONAL AMP
W	LM1458N DUAL OPERATIONAL AMP
X	LM1458N DUAL OPERATIONAL AMP
Y	LM1458N DUAL OPERATIONAL AMP
Z	LM311 VOLTAGE COMPARATOR
AA	4066B QUAD BILATERAL SWITCH
BB	LM3302N QUAD COMPARATOR
CC	LM1458N DUAL OPERATIONAL AMP
DD	ICL8013BCTZ 4 QUADRANT ANGL MULT

TABLE 7-3 (continued)
PARTS LIST
60907D kVp COMPUTER BOARD

OTHER:

L1	LED RED MINATURE
L2	LED RED MINATURE
L3	LED RED MINATURE
L4	LED RED MINATURE
L5	LED RED MINATURE
SW1	DIP 6 POSITION ALCO ADE-06
SW2	DIP 6 POSITION ALCO ADE-06
SW3	DIP 6 POSITION ALCO ADE-06
SW4	DIP 6 POSITION ALCO ADE-06
SW5	DIP 6 POSITION ALCO ADE-06
SW6	DIP 6 POSITION ALCO ADE-06

TABLE 7-4

PARTS LIST
60916C POWER SUPPLY BOARD

RESISTORS:

R1	47 OHM 5% 1/4W
R2	470 OHM 5% 1/4W
R3	10 OHM 5% 1/4W
R4	10 OHM 5% 1/4W
R5	1.0K OHM 5% 1/4W
R6	680 OHM 5% 1/4W
R7	2.2K OHM 5% 1/4W
R8	2.2K OHM 5% 1/4W
R9	22 OHM 5% 1/4W
R10	4.7K OHM 5% 1/4W
R11	4.7K OHM 5% 1/4W
R12	4.7K OHM 5% 1/4W
R13	10K OHM 5% 1/4W

CAPACITORS:

C1	1.0 MFD 50V MONOLITHIC CERAMIC
C2	2000 MFD 25V ALUMINUM/AXIAL LEADS
C3	15 MFD 35V DIPPED TANTALUM
C4	15 MFD 35V DIPPED TANTALUM
C5	100 MFD 25V ALUMINUM/AXIAL LEADS
C6	100 MFD 25V ALUMINUM/AXIAL LEADS
C7	1.0 MFD 50V MONOLITHIC CERAMIC
C8	.01 MFD 50V DISC CERAMIC
C9	22 MFD 35V ALUMINUM/AXIAL LEADS
C10	1.0 MFD 50V MONOLITHIC CERAMIC
C11	1.0 MFD 50V MONOLITHIC CERAMIC

DIODES:

D1	1N4004 1 AMP 400V PRV
D2	1N4004 1 AMP 400V PRV
D3	1N4004 1 AMP 400V PRV
D4	1N4004 1 AMP 400V PRV
D5	1N4004 1 AMP 400V PRV
D6	1N4004 1 AMP 400V PRV
D7	1N4004 1 AMP 400V PRV
D8	KBP02 BRIDGE RECT 1.5A 200V PRV
D9	1N4004 1 AMP 400V PRV
D10	1N4004 1 AMP 400V PRV
D11	1N4004 1 AMP 400V PRV

IC'S:

A	LM7912 -12V 1.5A REGULATOR
B	7812 +12V REGULATOR TO-220

TABLE 7-4 (continued)

PARTS LIST
60916C POWER SUPPLY BOARD

TRANSISTORS:

Q1	2N4123 NPN GENERAL PURPOSE TO-92
Q2	2N4123 NPN GENERAL PURPOSE TO-92
Q3	2N4125 PNP GENERAL PURPOSE TO-92

OTHER:

RY1	KHU17D18-12VDC 4PDT P&B
RY2	W172DIP-3 9VDC SPST MANGECRAFT
RY3	W172DIP-3 9VDC SPST MANGECRAFT
RY4	W172DIP-3 9VDC SPST MANGECRAFT
RY5	KHU17D18-12VDC 4PDT P&B
RY6	KHU17D18-12VDC 4PDT P&B
RY7	KHU17D18-12VDC 4PDT P&B
SW1	TOGGLE SPOT C+K 7101SYCB PCB MTG
TSA	BLOCK, BARRIER RDI 6PCV-12
TSB	BLOCK, BARRIER RDI 6PCV-06
J1	CONNECTOR, BDA09SU BEAU
J2	CONNECTOR, BDA09SU BEAU
J3	CONNECTOR, BDA09SU BEAU
J4	HEADER, SAMTEC TSW-136-07-GS
J5	HEADER, AMP 640388-6

TABLE 7-5

PARTS LIST
61017C DISPLAY BOARD A3365-G

RESISTORS:

R1	10K OHM 5% 1/4W
R2	100K OHM 5% 1/4W
R3	1.0K OHM 5% 1/4W
R4	220 OHM 5% 1/4W
R5	10K OHM 5% 1/4W
R6	4.7M OHM 5% 1/4W
R7	68 OHM 5% 1/4W
R8	10K TOP ADJ 20T VAN 752-208
R9	10K OHM 5% 1/4W
R10	10K OHM 5% 1/4W
R11	10K OHM 5% 1/4W
R12	1.0M OHM 5% 1/4W
R13	47K OHM 5% 1/4W
R14	68 OHM 5% 1/4W
R15	68 OHM 5% 1/4W
R16	68 OHM 5% 1/4W
R17	68 OHM 5% 1/4W
R18	68 OHM 5% 1/4W
R19	68 OHM 5% 1/4W
R20	10K OHM 5% 1/4W
R21	10K OHM 5% 1/4W
R22	10K OHM 5% 1/4W
R23	47K OHM 5% 1/4W
R24	470 OHM 5% 1/4W
R25	470 OHM 5% 1/4W
R26	1.0M OHM 5% 1/4W
R27	4.7M OHM 5% 1/4W
R28	100K OHM 5% 1/4W
R29	10K OHM 5% 1/4W
R30	2.2K OHM 5% 1/4W
R31	47K OHM 5% 1/4W
R32	470 OHM 5% 1/4W
R33	68 OHM 5% 1/4W
R34	47K OHM 5% 1/4W
R35	10K OHM 5% 1/4W
R36	4.7M OHM 5% 1/4W
R37	10K OHM 5% 1/4W

CAPACITORS:

C1	100 PF 1KV DISC CERAMIC
C2	100 PF 1KV DISC CERAMIC
C3	1.0 MFD 50V MONOLITHIC CERAMIC
C4	.01 MFD 200V FILM RADIAL LEADS
C5	.01 MFD 50V DISC CERAMIC
C6	1.0 MFD 50V MONOLITHIC CERAMIC
C7	.001 MFD 50V DISC CERAMIC TC=YSF
C8	.01 MFD 50V DISC CERAMIC
C9	15 MFD 25V DIPPED TANTALUM
C10	1.0 MFD 50V MONOLITHIC CERAMIC
C11	.001 MFD 50V DISC CERAMIC TC=YSF
C12	.001 MFD 50V DISC CERAMIC TC=YSF
C13	.01 MFD 50V DISC CERAMIC
C14	1.0 MFD 50V MONOLITHIC CERAMIC
C15	1.0 MFD 50V MONOLITHIC CERAMIC
C16	1.0 MFD 50V MONOLITHIC CERAMIC
C17	.001 MFD 50V DISC CERAMIC TC=YSF
C18	.001 MFD 50V DISC CERAMIC TC=YSF
C19	.001 MFD 50V DISC CERAMIC TC=YSF

DIODES:

D1	1N4148 150 mA 75V PRV
D2	1N4148 150 mA 75V PRV
D3	1N4148 150 mA 75V PRV
D4	1N4148 150 mA 75V PRV
D5	1N4148 150 mA 75V PRV
D6	1N4148 150 mA 75V PRV
D7	1N4148 150 mA 75V PRV

TABLE 7-5 (continued)

PARTS LIST
61017C DISPLAY BOARD A3365-G

TRANSISTORS:

Q1	2N4123 NPN GEN PURPOSE TO-92
Q2	2N4123 NPN GEN PURPOSE TO-92

IC'S:

A	74C00N QUAD 2 INPUT NAND GATE
B	AD537 JH VOLTS TO FREQ CONVERTER
C	74C14N HEX SCHMITT TRIGGER
D	DS75494 HEX DIGIT DISPLAY DRIVER
E	74C928N 4-DIG CTR W17 SEG OUT DR
F	74C20N DUAL 4 INPUT NAND GATE
H	CD4020A 14 STG BINARY COUNTER
J	LM34OT +5V REGULATOR
K	4040B 12 STAGE BINARY COUNTER
L	74C10N TRIPLE 3 INPUT NAND GATE
M	4093B QUAD 2 INP NAND SCHMIT TRG
N	74C00N QUAD 2 INPUT NAND GATE
P	74C14N HEX SCHMITT TRIGGER
R	74C14N HEX SCHMITT TRIGGER
S	4040B 12 STAGE BINARY COUNTER

OTHER:

L1	LED RECTANGULAR, GREEN CMD 54124
L2	LED RECTANGULAR, RED MV57124
L3	LED RECTANGULAR, RED MV57124
X1	CRYSTAL, 4.096 MHZ HC-18 CASE

TABLE 7-6

PARTS LIST
60917C PRE-AMP, THREE FIELD IONIZATION CHAMBER

RESISTORS:

R1	100 OHM 5% 1/4W
R2	3.3K OHM 5% 1/4W
R3	100 OHM 5% 1/4W
R4	2.7K OHM 5% 1/4W
R5	22K OHM 5% 1/4W
R6	3.3K OHM 5% 1/4W
R9	470 OHM 5% 1/4W
R10	560 OHM 5% 1/4W
R11	10K OHM 5% 1/4W
R12	20K TOP ADJ 4T BOURNS 3339P-1
R13	1.0M OHM 5% 1/4W
R14	10K OHM 5% 1/4W
R15	20K TOP ADJ 4T BOURNS 3339P-1
R16	22K OHM 5% 1/4W
R17	100K OHM 5% 1/4W
R18	10K MEG OHM 1/2W 10%
R19	1.0M OHM 5% 1/4W
R20	20K TOP ADJ 4T BOURNS
R21	10K OHM 5% 1/4W
R22	10K OHM 5% 1/4W
R23	100K OHM 5% 1/4W
R24	1.0M OHM 5% 1/4W
R25	20K TOP ADJ 4T BOURNS 3339P-1
R26	22K OHM 5% 1/4W
R27	10K MEG OHM 1/2W 10%
R28	10K OHM 5% 1/4W
R29	20K TOP ADJ 4T BOURNS 3339P-1
R30	10K OHM 5% 1/4W
R31	1.0K OHM 5% 1/4W
R32	20K TOP ADJ 4T BOURNS 3339P-1
R33	22K OHM 5% 1/4W
R34	100K OHM 5% 1/4W
R35	10K MEG OHM 1/2W 10%
R36	1.0M OHM 5% 1/4W
R37	20K TOP ADJ 4T BOURNS 3339P-1

CAPACITORS:

C1	.01 MFD 50V GLASS AXIAL LEADS
C2	15 MFD 25V DIPPED TANTALUM
C3	0.1 MFD 250V FILM RADIAL LEADS
C4	.01 MFD 50V GLASS AXIAL LEADS
C5	0.001 MFD 100V WMF 1D1
C6	0.001 MFD 100V WMF 1D1
C7	0.001 MFD 100V WMF 1D1
C8	1.0 MFD 50V MONOLITHIC CERAMI
C9	1.0 MFD 50V MONOLITHIC CERAMI
C10	15 MFD 25V DIPPED TANTALUM
C11	15 MFD 25V DIPPED TANTALUM

DIODES:

D1	1N4004 1 AMP 400V PRV
D2	1N4764 ZENER 100V 1.0W
D3	1N4764 ZENER 100V 1.0W
D4	1N4004 1 AMP 400V PRV
D5	1N4004 1 AMP 400V PRV
D6	1N4148 150 MA 75V PRV
D7	1N4148 150 MA 75V PRV
D8	1N4148 150 MA 75V PRV
D9	1N4148 150 MA 75V PRV
D10	1N4148 150 MA 75V PRV
D11	1N4148 150 MA 75V PRV
D12	1N4148 150 MA 75V PRV
D13	1N4148 150 MA 75V PRV
D14	1N4148 150 MA 75V PRV
D15	1N4148 150 MA 75V PRV

TABLE 7-6 (continued)

PARTS LIST
60917C PRE-AMP, THREE FIELD IONIZATION CHAMBER

TRANSISTORS:

Q1	TIS99 NPN GEN PURPOSE TO-92

IC'S:

A	74C14N HEX SCHMITT TRIGGER
C	LM741CN HI PERFORMANCE OP AMP
D	H11F1 OPTOISOLATOR
E	AD549 JH PREC LO DRFT FET OP AMP
F	H11F1 OPTOISOLATOR
H	AD549 JH PREC LO DRFT FET OP AMP
J	H11F1 OPTOISOLATOR
K	AD549 JH PREC LO DRFT FET OP AMP
L	79L05 -5 .1A REGULATOR
M	78L05 +5 .1A REGULATOR

OTHER:

RY1	W107DIP3-9V DC SPST MAGNECRAFT RELAY
RY2	W107DIP3-9V DC SPST MAGNECRAFT RELAY
RY3	W107DIP3-9V DC SPST MAGNECRAFT RELAY
TR1	H-100, STEP-UP ALTRAN TRANSFORMER

TABLE 7-7

PARTS LIST
60940D PRE-AMP, SINGLE FIELD IONIZATION CHAMBER

RESISTORS:

R1	100K TOP ADJ 20T BOURNS 3266W1
R2	10K MEG OHM 1/2W 10%
R3	100K OHM 5% 1/4W
R4	1.0M OHM 5% 1/4W
R5	10K OHM 5% 1/4W
R6	2.2M OHM 5% 1/4W
R7	100K OHM 5% 1/4W
R8	4.7K OHM 5% 1/4W
R9	220 OHM 5% 1/4W
R10	20K TOP ADJ 4T BOURNS 3339P-1
R11	100K TOP ADJ 20T BOURNS 3266W1
R12	1.0K OHM 5% 1/4W
R15	100 OHM 5% 1/4W
R16	2.7K OHM 5% 1/4W
R17	22K OHM 5% 1/4W
R18	3.3K OHM 5% 1/4W
R19	100 OHM 5% 1/4W

CAPACITORS:

C1	1.0 MFD 50V MONOLITHIC CERAMIC
C2	1.0 MFD 50V MONOLITHIC CERAMIC
C3	1.0 MFD 50V MONOLITHIC CERAMIC
C4	1.0 MFD 50V MONOLITHIC CERAMIC
C5	1.0 MFD 50V MONOLITHIC CERAMIC
C6	0.001 MFD 100V WMF 1D1
C7	.01 MFD 50V GLASS AXIAL LEADS
C8	0.1 MFD 250V FILM RADIAL LEADS
C9	0.1 MFD 250V FILM RADIAL LEADS
C10	15 MFD 25V DIPPED TANTALUM
C11	.01 MFD 50V GLASS AXIAL LEADS

DIODES:

D1	1N754 ZENER 6.8V 0.5W
D2	1N4148 150 MA 75V PRV
D3	1N4007 1AMP 1KV PRV
D4	1N4007 1AMP 1KV PRV
D5	1N4764 ZENER 100V 1.0W
D6	1N4764 ZENER 100V 1.0W
D7	1N4148 150 MA 75V PRV
D8	1N4004 1 AMP 400V PRV

IC'S & TRANSISTORS:

A	78L05 +5 .1A REGULATOR
B	79L05 -5 .1A REGULATOR
C	CA3140B BIMOS OPERATIONAL AMP
E	74C14N HEX SCHMITT TRIGGER
F	TIS99 NPN GEN PURPOSE TO-92
H	AD549 JH PREC LO DRFT FET OP AMP

OTHER:

RY1	W171DIP-12V DC SPST MAGNECRAFT RELAY
TR1	H-100, STEP-UP ALTRAN TRANSFORMER

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CHAPTER 14

IMAGE INTENSIFIER

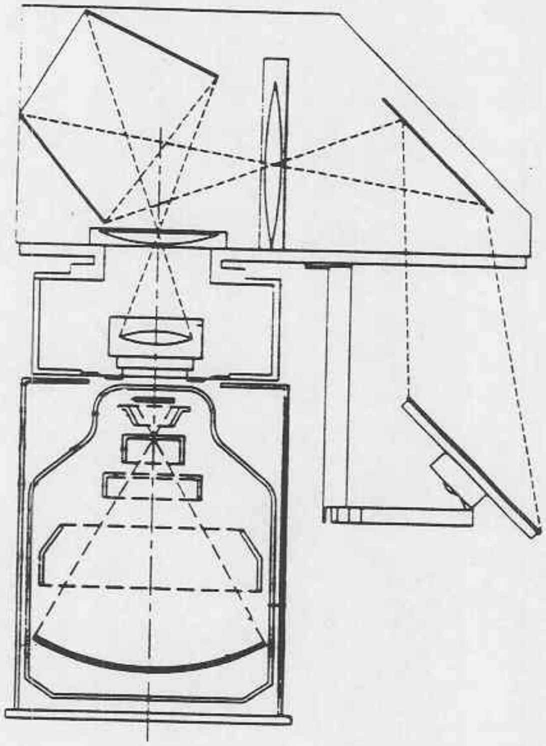


TABLE OF CONTENTS
CHAPTER 14 - IMAGE INTENSIFIER

SECTION NUMBER	DESCRIPTION	PAGE NUMBER
SECTION 1 - GENERAL		1-1
1.1	SCOPE	1-1
1.2	DESCRIPTION	1-1
1.3	SPECIFICATIONS	1-3
1.3.1	PHYSICAL DIMENSIONS	1-3
1.3.2	WEIGHT	1-3
1.3.3	ELECTRICAL	1-3
1.3.4	OPTICAL CHARACTERISTICS	1-4
1.3.5	MISCELLANEOUS	1-4
1.4	EQUIPMENT SUPPLIED	1-4
1.4.1	EQUIPMENT REQUIRED BUT NOT SUPPLIED	1-4
1.4.2	TEST EQUIPMENT	1-4
SECTION 2 - THEORY OF OPERATION		2-1
2.1	INTRODUCTION	2-1
2.2	IMAGE INTENSIFICATION TUBE	2-1
2.3	POWER SUPPLY	2-1
2.3.1	LOW VOLTAGE SUPPLY	2-1
2.3.2	DC-TO-AC HIGH VOLTAGE CONVERTER	2-4
2.3.3	STABILIZATION AND CONTROL OF OUTPUT VOLTAGE V5	2-4
2.3.4	OUTPUT VOLTAGE (V5) MULTIPLIER	2-4
2.3.5	VOLTAGE DIVIDER	2-4
SECTION 3 - MAINTENANCE		3-1
3.1	GENERAL MAINTENANCE	3-1
3.2	STORAGE MAINTENANCE	3-1
3.3	IMAGE TUBE FOCUS	3-2
3.4	REPLACING THE POWER SUPPLY	3-3
SECTION 4 - PARTS LIST		4-1

LIST OF FIGURES

FIGURE NUMBER	DESCRIPTION	PAGE NUMBER
1-1	IMAGE INTENSIFICATION SYSTEM OVER VIEW	1-2
2-1	FOCUSING ELECTRONS	2-2
2-2	IMAGE INTENSIFIER POWER SUPPLY CIRCUIT	2-3
3-1	POTENTIOMETER LOCATIONS	3-4
4-1	LAYOUT FOR 5536.822.04 MIL 6" MIRROR/LENS SUPPORT MNT ASM	4-2
4-2	LAYOUT FOR 5536.822.05 6" EUREKA/THOMSON OPTICS SPRT ASM	4-5

LIST OF TABLES

TABLE NUMBER	DESCRIPTION	PAGE NUMBER
4-1	PARTS LIST FOR 5536.822.04 MIL 6" MIRROR/LENS SUPPORT MNT ASM	4-3
4-2	PARTS LIST FOR 5536.822.05 6" EUREKA/THOMSON OPTICS SPRT ASM	4-6

CHAPTER 14 - IMAGE INTENSIFIER

SECTION 1 - GENERAL

1.1 SCOPE

This chapter describes the maintenance of the Continental X-ray Corporation image intensifier system (FIGURE 1-1). This intensifier system is only part of a diagnostic x-ray system. Other components are also required to complete a system. These components are the subjects of their own chapters, they will not be discussed except as they apply to the image intensifier system.

It is assumed that all installation, operating, and maintenance personnel are qualified to perform their assigned functions. This includes becoming familiar with the contents of this chapter because it contains information needed for compliance with Bureau of Radiological Health (BRH), Food and Drug Administration (FDA), and Department of Health, Education and Welfare (HEW) regulations.

1.2 DESCRIPTION

The Continental X-ray image intensifier system consists of an image intensifier tube encased in a light alloy housing, a single field power supply that is mounted to the housing, a 50mm f 0.75 collimating lens and adapter plate, and the mirror optics assembly.

The image intensifier tube converts the x-ray pattern into a light image of high brightness and contrast. The tube's housing is equipped with a high-permeability alloy shielding that provides efficient protection of the Intensifier Tube against the earth's magnetic field, or stray magnetic fields due to surrounding equipment. An internal lead lining suppresses the transmission of radiation beyond the tube's external housing, and is effective for energies up to 150KVP.

The single field power supply is mounted to the rear of the intensifier tube housing and supplies all the electrode voltages necessary for the operation of the image intensifier tube.

The collimating lens mounts between the intensifier tube and the mirror optics assembly via the adapter plate, which also houses the lens. The lens gathers light output from the output phosphor of the intensifier tube and collimates the light into parallel rays to allow image formation by the optics assembly.

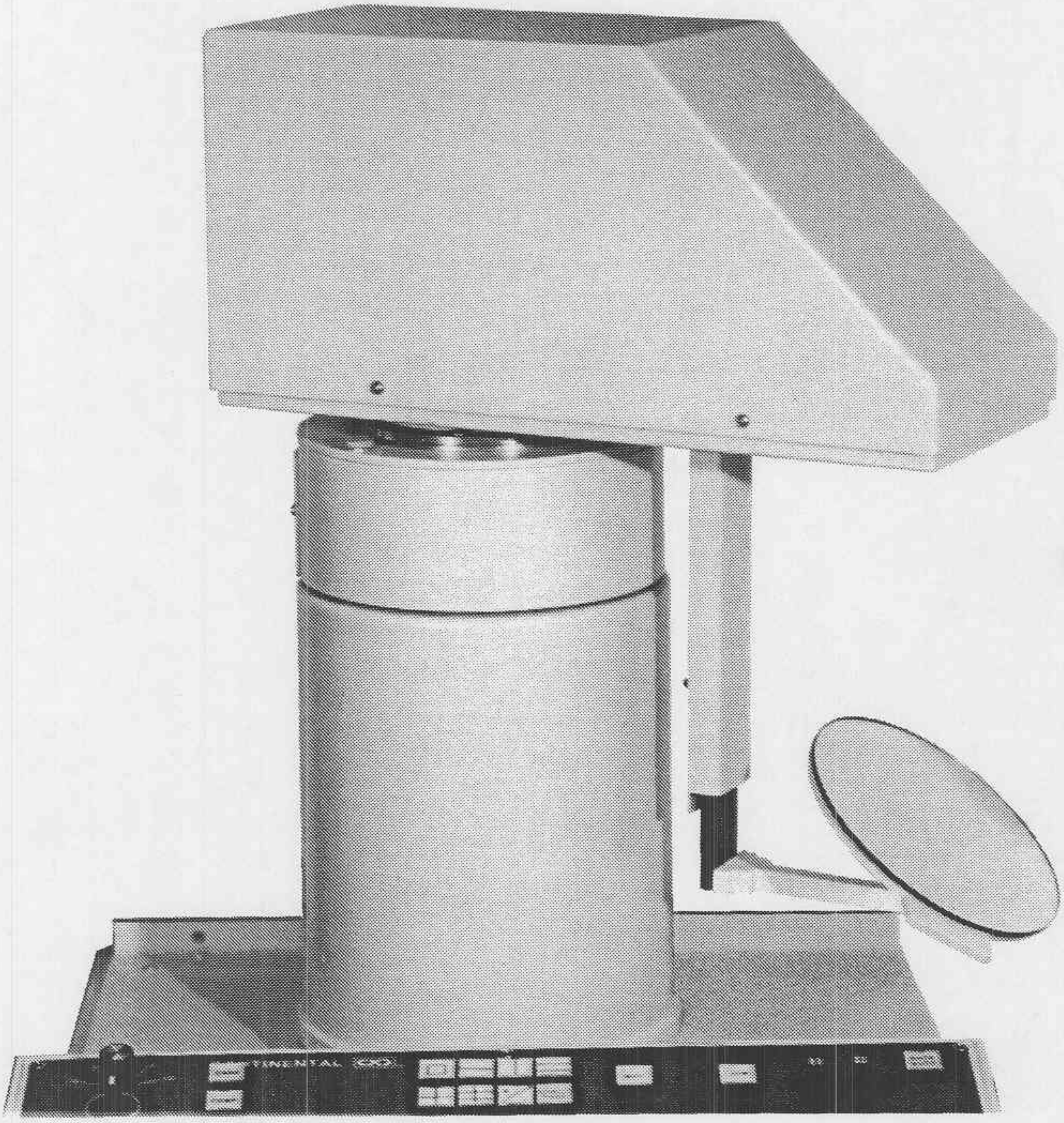


FIGURE 1-1 IMAGE INTENSIFICATION SYSTEM OVERVIEW

1.2 DESCRIPTION (continued)

The mirror optics assembly is an infinite focus optical relay system for mirror viewing. Two convex lenses within the optics housing relay the light rays from the intensifier tube and project the image onto a viewing mirror that is mounted to the outside of the optics housing.

1.3 SPECIFICATIONS

1.3.1 PHYSICAL DIMENSIONS

9" X 19 1/8" X 22 1/2"(229mm X 486mm X 571mm)

1.3.2 WEIGHT

48 lbs (21.77 kg)

NOTE:

ABOVE DIMENSIONS ARE FOR ENTIRE IMAGE INTENSIFICATION SYSTEM WHICH INCLUDES THE INTENSIFIER TUBE, THE MIRROR OPTICS ASSEMBLY AND THE MOUNTING PLATE.

1.3.3 ELECTRICAL

- **Power Requirements** 110VAC 50/60Hz
- **Operational Voltages**

Photocathode PC	0V
Electrode g1 voltage	90 to 270V
Electrode g2 voltage	720 to 1080V
Electrode g3 voltage	3.42KV
Anode a voltage	27KV

- **GENERAL CHARACTERISTICS (POWER SUPPLY)**

Input Voltage	Tolerance	Max Current	Ave Current	Fuse
110VAC 50/60Hz	± 10%	80mA	40mA	100mA

Output	Adjustment Pot	Voltage	To electrode	Max Current
V5	P1	+27 ± 0.15KVDC	Anode	3uA
V4		+2.5 to 3.0KVDC	g4	20uA
V3	P2	+3.4 ± 0.1KVDC	g3	1uA
V2	P5	+740 to 1080VDC	g2	1uA
V1	P8	+90 to 270VDC	g1	1uA

RIPPLE AND STABILITY OF OUTPUT VOLTAGES V1-V2-V3-V5 ARE WITHIN 0.1%

1.3.4 OPTICAL CHARACTERISTICS

- **Input/Output**

output image diameter	.571" + .02" (14.5 ± 0.5mm)
useful input diameter	5.71" (145mm)

- **RESOLUTION**

	min	typ	units
Optimum focusing without filtration			
-central 70% diameter	40	42	lp.cm-l
-70 to 90% diameter	40	42	lp.cm-l
-90 to 95% diameter	38	40	lp.cm-l
Optimum focusing with filtration			
-central 70% diameter	38	40	lp.cm-l
-medium 70 to 90% diameter	38	40	lp.cm-l
-peripheral 90 to 95% diameter	36	38	lp.cm-l

1.3.5 MISCELLANEOUS

Insert Tube	6" (15 cm) cesium iodide
Collimating lens	50mm f 0.75
Viewing mirror	6" diameter

1.4 EQUIPMENT SUPPLIED

Continental X-ray image intensifier system with power supply and interconnecting cables.
Auxiliary power cord for "seasoning" image intensifier system

1.4.1 EQUIPMENT REQUIRED BUT NOT SUPPLIED

0.2mm spaced metallic wire mesh (stainless steel or copper)

1.4.2 TEST EQUIPMENT

Voltmeter
High Voltage Probe capable of withstanding at least 30KV

SECTION 2 - THEORY OF OPERATION

2.1 INTRODUCTION

This section describes the electrical and electronic circuitry used in the Continental X-ray Corporation image intensifier system. Much of this solid-state circuitry is mounted on printed circuit boards. The schematic diagrams of the circuitry discussed are located in this chapter. See them, as needed, while reading this circuit description.

2.2 IMAGE INTENSIFICATION TUBE:

Image intensification requires converting photons into electrons, then accelerating these electrons by means of an electrical field. The kinetic energy accumulated by these accelerated electrons is then converted into a brighter visible image.

The x-ray image intensifier has a built-in x-ray photon detector. The x-ray beam emerging from the subject being examined carries the x-ray image. This image passes through an input window made of a special low-absorption, low-scatter material. The x-ray beam is then absorbed by the input detector screen, where the x-ray photons are converted into light photons. A photocathode, coupled to the input screen, is excited by these light photons and produces electrons. These electrons are accelerated and focused by appropriate electric fields, and impinge on an output fluorescent screen. This screen converts them into light photons, giving a demagnified high-brightness output image. The brightness gain is obtained partly from the energy imparted to the electrons during their acceleration, and partly from electron image demagnification (FIGURE 2-1).

2.3 POWER SUPPLY:

The circuit diagram (FIGURE 2-2) for the power supply can be considered in five (5) subsections; low voltage supply, dc to ac high voltage converter, output voltage (V5) stabilizer, output voltage (V5) multiplier, and voltage divider.

2.3.1 LOW VOLTAGE SUPPLY

The supply voltage (selected by jumper S1) is stepped down to about 24 V by transformer T1. This is then rectified by diode-bridge rectifier CR1, and smoothed by capacitor C1. This low dc voltage is always sufficient to feed the IC voltage regulators (IC1 and IC2), even when the line-supply voltage drops to its minimum value. IC1 delivers from 17.3 to 18.7 V, and IC2 delivers from 14.3 to 15.7 V, C2, C3 and C4 preventing oscillation. IC1 and IC2 are protected against output short circuits, accidental overloads, and are temperature-stabilized.

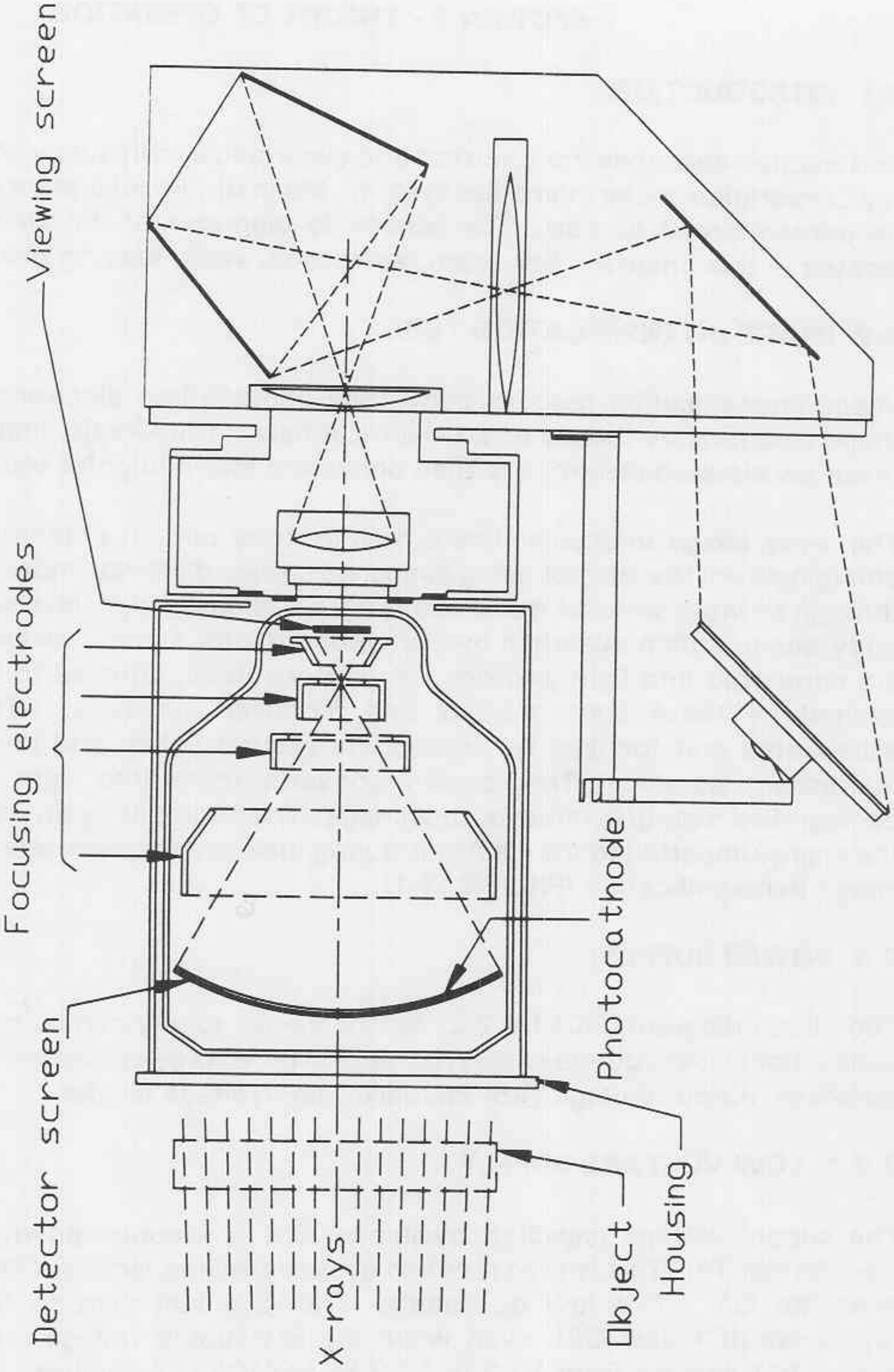

Viewing screen
Focusing electrodes
Photocathode
Detector screen
X-rays
Object
Housing

FIGURE 2-1 FOCUSING ELECTRONS

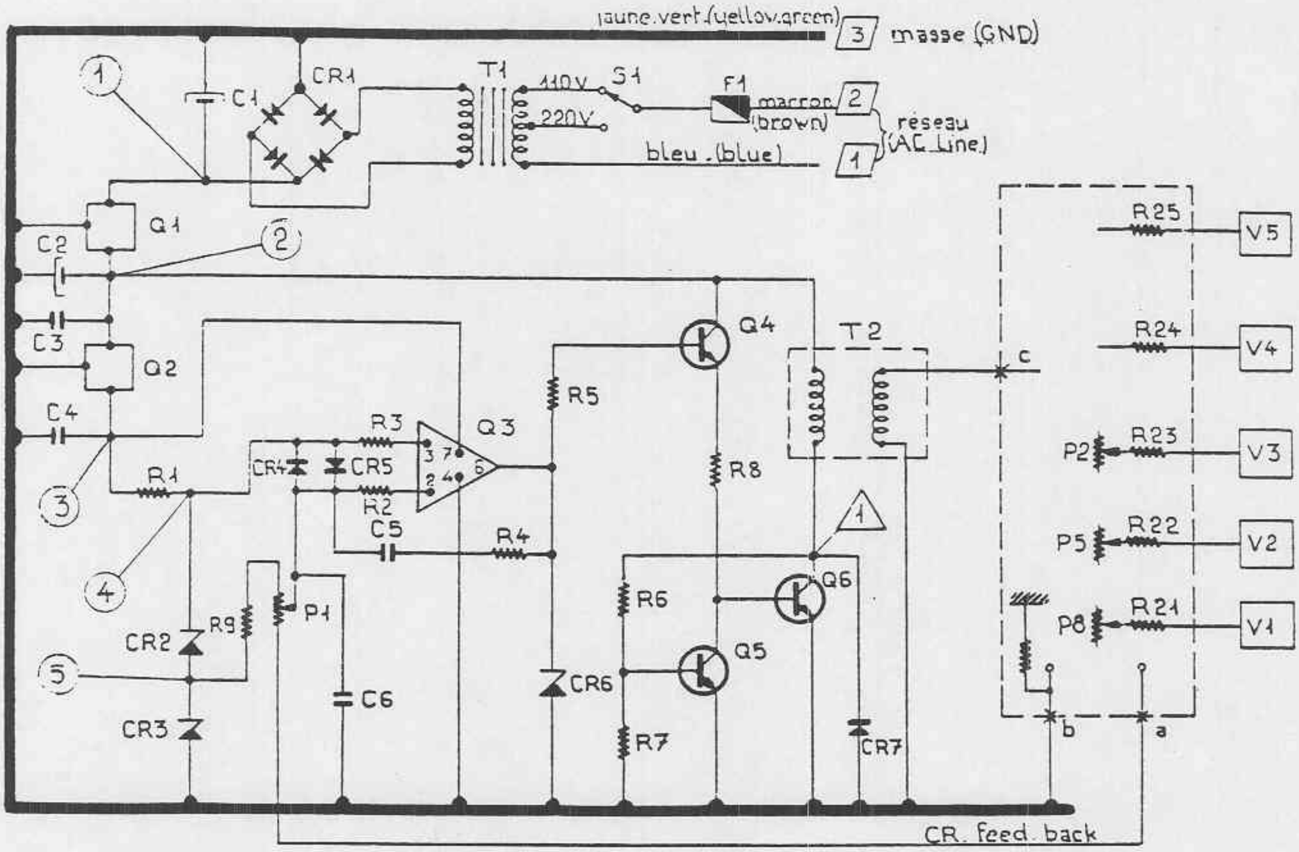

jaune.vert.(yellow.green)
3
masse (GND)
1
C1
CR1
T1
110V
220V
S1
F1
marron (brown)
2
réseau (AC Line)
bleu.(blue)
1
Q1
C2
2
C3
Q2
C4
3
R1
4
CR2
R9
5
CR3
P1
C6
CR4
CR5
R3
R2
Q3
3
7
2
4
6
C5
R4
R5
Q4
CR6
R8
T2
1
R6
Q6
Q5
R7
CR7
c
R25
V5
R24
V4
P2
R23
V3
P5
R22
V2
P8
R21
V1
b
a
CR. feed. back

FIGURE 2-2 IMAGE INTENSIFIER POWER SUPPLY CIRCUIT

2.3.2 DC-TO-AC HIGH VOLTAGE CONVERTER

This consists of a blocking oscillator (driven by the 24VDC line) followed by a transformer, T2. The blocking oscillator consists of switching transistor Q3 controlled by transistor Q2. The frequency of the oscillator is determined by the resonant frequency of the transformer primary and its associated capacitors. The oscillator is controlled by adjusting the base potential of Q3, this potential being supplied by Q1.

2.3.3 STABILIZATION AND CONTROL OF OUTPUT VOLTAGE V5

A fraction of output voltage V5 is compared to a reference potential derived from the network consisting of R1, CR2 and CR3. V5 is adjustable by the setting of P1. The difference between these two potentials is applied to the input of op-amp IC3, which determines the base potential of Q2. If V5 varies for some reason (change in load for example), its is reestablished by a potential inversely proportional to the change in the Q1 output potential.

2.3.4 OUTPUT VOLTAGE (V5) MULTIPLIER

The multiplier consists of several identical units, each one of which is formed by a rectifier and a capacitor.

2.3.5 VOLTAGE DIVIDER

The voltages for image intensifier tube electrodes g3, g2 and g1 are derived from V6 (the output voltage of the multiplier) by means of a voltage divider circuit. This consists of a network of high-stability resistors, potentiometers P2, P5 and P8 being used to adjust the electrode voltages to the values given in the Test Report of the x-ray image intensifier tube in use. This circuit also supplies the tube ion pump voltage, V4, and is protected by 4.7 M ohm resistors inserted in each output-voltage line.

SECTION 3 - MAINTENANCE

3.1 GENERAL MAINTENANCE

The I-7802 Image Intensifier System requires a minimal amount of maintenance, especially when in use. It is recommended that the painted metal portions of the Intensifier System be wiped down with a damp cloth, and the outer lens and viewing mirror cleaned with lens tissue and lens cleaning solution every 30 days. This will prevent dust accumulation that may affect the operation of the system.

3.2 STORAGE MAINTENANCE

When the intensifier system is not in use for an extended period of time or when it is being stored, it becomes necessary to **"SEASON"** the intensifier tube. **"SEASONING"** is done by applying electrical current to the tube for a 24 hour period.

If the tube has been installed and has been idle for an extended period of time, i.e. 4 to 6 months, power can be applied to it through the spot film device. Check to make sure the power supply cord is connected to the spot film device control panel and then turn the power on and let it run for 24 hours before operating.

IF THE TUBE IS BEING STORED, IT IS RECOMMENDED THAT THE TUBE BE "SEASONED" EVERY 6 MONTHS. In its un-installed state, power to the tube can be applied by using the auxiliary power cord supplied with the system. The auxiliary cord is equipped with a bulkhead receptacle which will accept the bulkhead plug on the power supply cord. Once the auxiliary cord and the power supply cord are connected, the auxiliary cord can be plugged into any 120VAC line. Allow current to run to the tube for 24 hours.

3.3 IMAGE TUBE FOCUS

WARNING

THE SCREWDRIVER USED TO ADJUST P2 MUST HAVE AN INSULATING SHAFT AND HANDLE. THE POTENTIOMETER SLIDER IS AT 3800 V WITH RESPECT TO GROUND, AND THE INSULATION VALUE BETWEEN THE SLIDER ANT THE POTENTIOMETER SHAFT IS ONLY 1000 V.

The potentiometers for focus adjustment of the intensifier tube are located on the left side of the power supply, and are labeled. The outer cover of the power supply must be removed to have access to these potentiometers (FIGURE 3-1).

3.3 IMAGE TUBE FOCUS (continued)

For the adjustment procedure, it is necessary to use a 0.2-mm spaced metallic (stainless steel or copper) wire mesh of 2/10mm diameter that can be attached, with masking tape, to the spot film device directly beneath the intensifier tube. This screen will provide an adequate image to ensure proper focusing.

With the screen in place, initiate a fluoroscopic exposure and begin adjusting. (Refer to System Operation, Chapter 5 for taking a fluoroscopic exposure.)

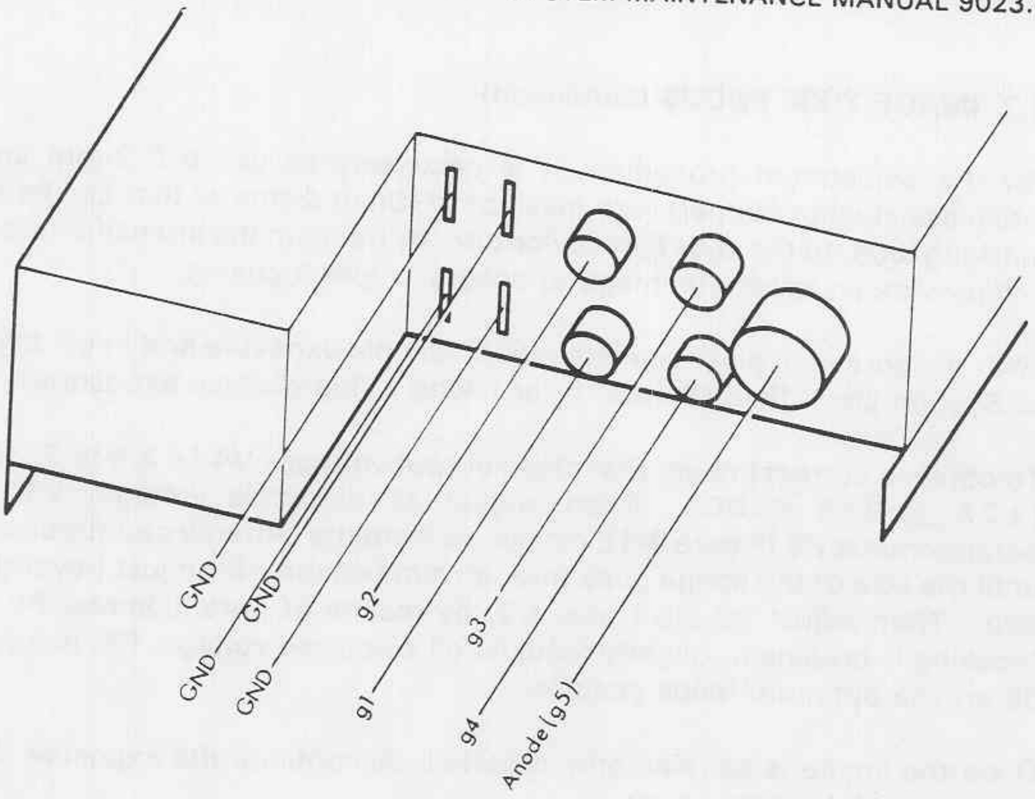
To obtain a correct image, first checkoutput voltages V4 (+ 2.5 to 3.0 KVDC) and V5 (+ 27 ± 0.15 KVDC). Then, adjust g1 electrode voltage, V1, by means of potentiometer P8 (Figure 3-1), clockwise from the extreme counterclockwise position until the size of the image goes through a maximum. Stop just beyond the maximum size. Then adjust g2 electrode, V2, by means of potentiometer P5 until optimum focusing is obtained. Slightly readjust g1 electrode voltage, P8, in both directions to determine optimum focus position.

Once the image is satisfactorily adjusted, discontinue the exposure and replace the power supply's outer cover.

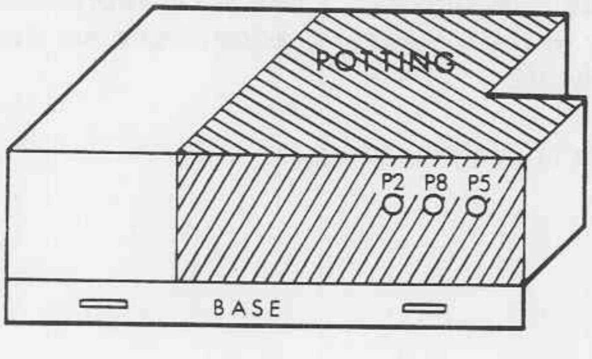
3.4 REPLACING THE POWER SUPPLY

To replace the power supply, first disconnect the power cable from the spot film device control panel. The cover on the power supply should be removed if it has not been done already. Disconnect the 8 (eight) wires running from the tube to the power supply, making sure to note where each wire is terminated. There are 4 (four) phillips head screws which hold the power supply to the mounting bracket. Remove those screws and pull the defective power supply off.

To attach a new power supply, reverse the above procedure.


GND
GND
GND
GND
g2
g1
g3
g4
Anode (g5)

- Electrode connections.


POTTING
P2
P8
P5
BASE

WARNING

The screwdriver used to adjust P2 must have an insulating shaft and handle :

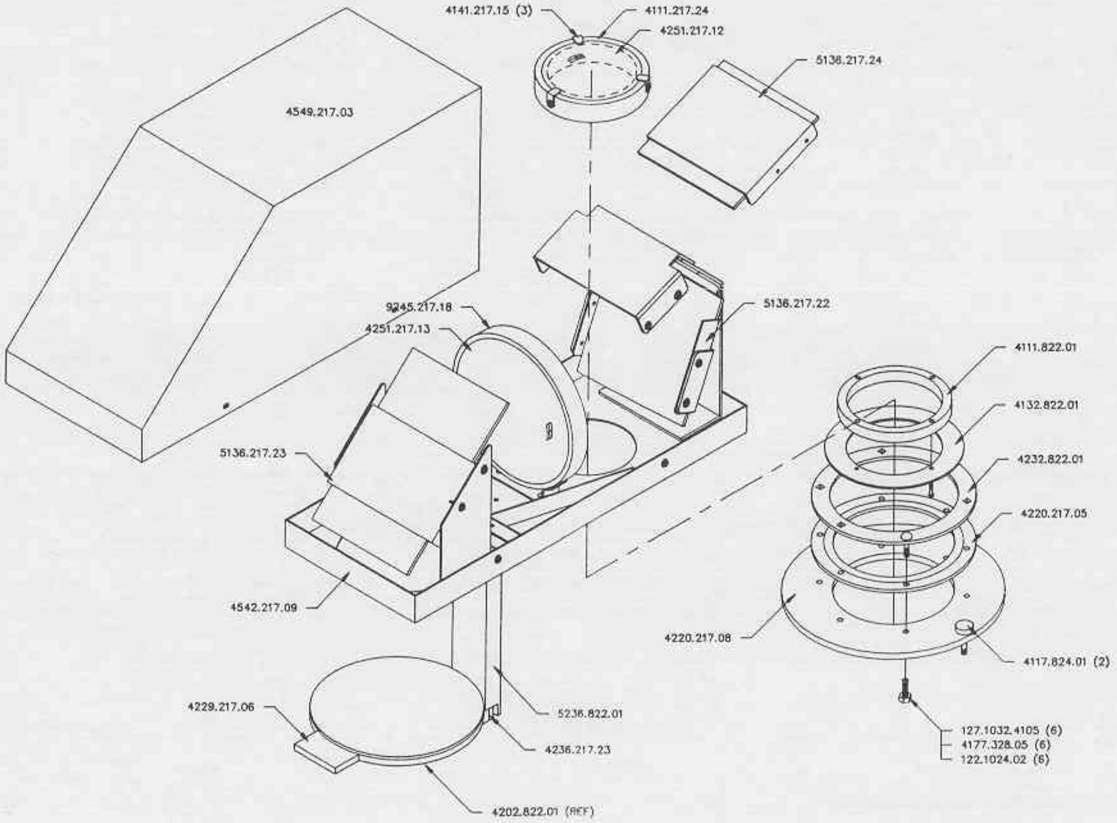
The potentiometer slider is at 3800 V with respect to ground, and potentiometer shaft/slider isolation is only 1000 V.

FIGURE 3-1 POTENTIOMETER LOCATIONS

SECTION 4 - PARTS LIST

NOTE

This section printed on one side, only.


4141.217.15 (3)
4111.217.24
4251.217.12
5136.217.24
4549.217.03
9245.217.18
4251.217.13
5136.217.22
4111.822.01
4132.822.01
4232.822.01
4220.217.05
5136.217.23
4542.217.09
4220.217.08
4117.824.01 (2)
4229.217.06
5236.822.01
4236.217.23
127.1032.4105 (6)
4177.328.05 (6)
122.1024.02 (6)
4202.822.01 (REF)

MIL 6" MIRROR/LENS SUPPORT MNT ASM

FIGURE 4-1 LAYOUT FOR 5536.822.04

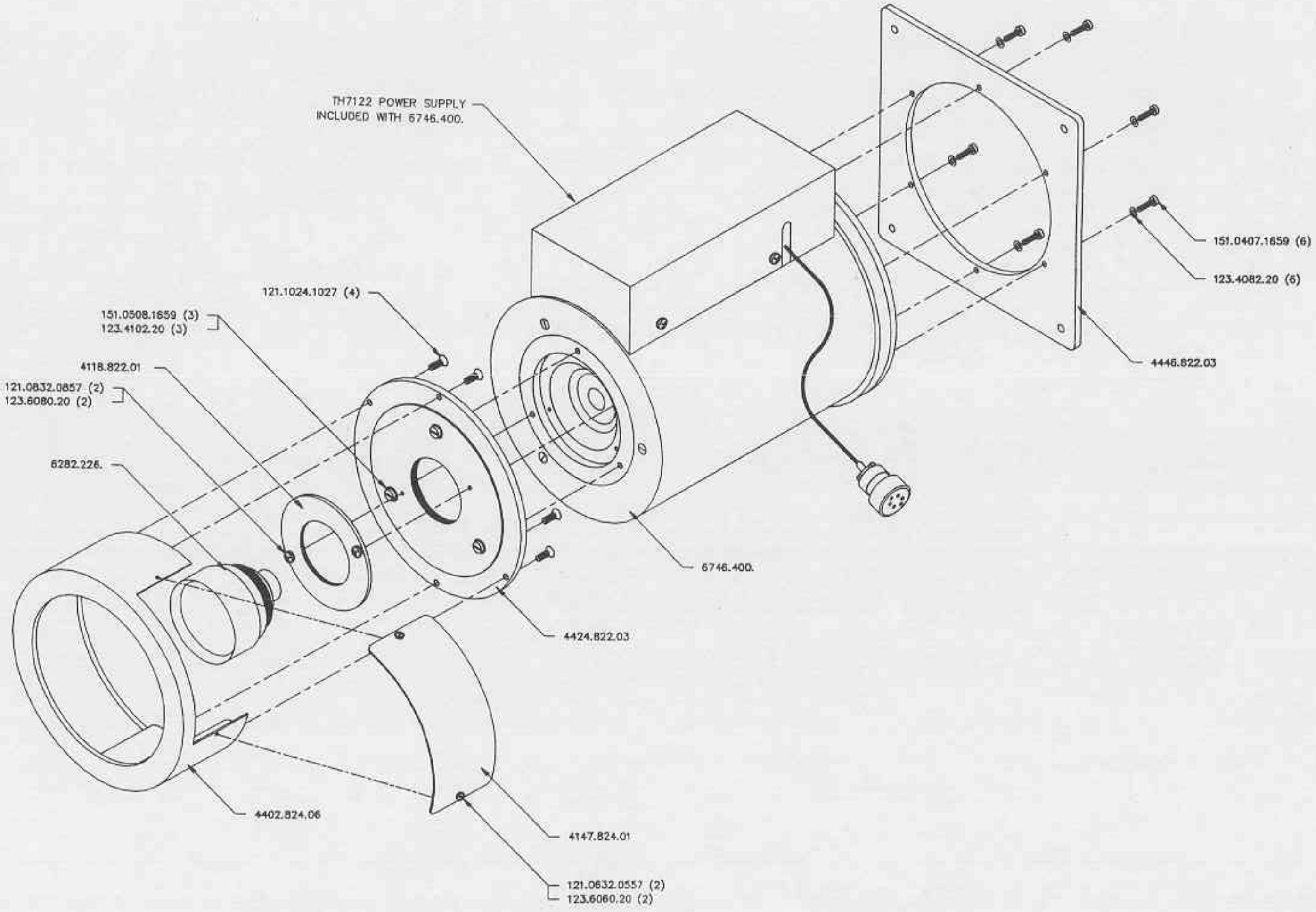
	Part Number	Description	Quantity	Reference Designators
1.	121.0632.0457	6-32 X 1/4 Pan Steel Phillips Screw	6 EA	
2.	121.0632.0557	6-32 X 5/16 Pan Steel Philips Screw	17 EA	
3.	121.0632.2057	6-32 X 1-1/4 Pan Steel Phlp Screw	4 EA	
4.	121.0832.0857	8-32 X 1/2 Pan Steel Phillips Screw	5 EA	
5.	122.0632.22	6-32 Double Chamfered Hex Steel Nut	4 EA	
6.	122.1024.02	10-24 Elastic Stop Nut-Nickel Platd	6 EA	
7.	123.1110.20	7/32ID 1/2OD 3/64Thk Stl SAE Washer	6 EA	
8.	123.1306.20	.150ID .375OD .032T Mach Scrw Washr	6 EA	
9.	123.4062.20	#6 Medium Pattern Split Lockwasher	10 EA	
10.	123.4082.20	#8 Medium Pattern Split Lockwasher	5 EA	
11.	123.6060.20	#6 Internal Tooth Steel Lockwasher	21 EA	
12.	127.1032.4105	3/16-24 X 1-1/4 Carriage Bolt	6 EA	
13.	4111.217.24	Field Lens Mount	1 EA	
14.	4111.822.01	Optics Swivel Lock Spacer	1 EA	
15.	4117.824.01	1/4-20 X 1.13 Screw Knob	2 EA	
16.	4132.822.01	Optics Swivel Lock Disc	1 EA	
17.	4140.822.05	Field Lens Support Shim	1 EA	
18.	4141.217.14	Image Intensifr Front Lens Retainer	5 EA	
19.	4141.217.15	Field Lens Retainer	2 EA	
20.	4151.217.25	Exit Window	1 EA	
21.	4177.328.05	Crittenden Bleeder Spring	6 EA	
22.	4220.217.05	Optics Bottom Bearing	1 EA	
23.	4220.217.08	3 Channel Mirror Mounting Plate	1 EA	
24.	4232.822.01	Optics Swivel Pressure Ring	1 EA	
25.	4251.217.12	Field Lens 470 Mm 3.5 D	1 EA	
26.	4251.217.13	Field Lens 280mm 5-11/16" Diameter	1 EA	

. . . continued on next page

TABLE 2-1 Parts List for 5536.822.04
Mil 6" Mirror/Lens Support Mnt Asm

	Part Number	Description	Quantity	Reference Designators
27.	4542.217.09	Optics Base Assembly	1 EA	
28.	4549.217.03	6 II Mirror Optics Cover	1 EA	
29.	5136.217.22	Transfer Mirror Assembly	1 EA	
30.	5136.217.23	Exit Mirror Assembly	1 EA	
31.	5136.217.24	Objective Mirror Assembly	1 EA	
32.	5236.822.01	6 External Mirror Slide	1 EA	
33.	9245.217.18	Field Lens Support Assembly	1 EA	

TABLE 2-1 Parts List for 5536.822.04
Mil 6" Mirror/Lens Support Mnt Asm


TH7122 POWER SUPPLY
INCLUDED WITH 6746.400.
121.1024.1027 (4)
151.0508.1659 (3)
123.4102.20 (3)
4118.822.01
121.0832.0857 (2)
123.6080.20 (2)
6282.226.
151.0407.1659 (6)
123.4082.20 (6)
4446.822.03
6746.400.
4424.822.03
4402.824.06
4147.824.01
121.0632.0557 (2)
123.6060.20 (2)

6" EUREKA/THOMSON OPTICS ASM

FIGURE 4-2 LAYOUT FOR 5536.822.05

	Part Number	Description	Quantity	Reference Designators
1.	121.0632.0557	6-32 X 5/16 Pan Steel Philips Screw	2 EA	
2.	121.0832.0857	8-32 X 1/2 Pan Steel Phillips Screw	2 EA	
3.	121.1024.1027	10-24 X 5/8 Flat Steel Philps Screw	4 EA	
4.	123.4082.20	#8 Medium Pattern Split Lockwasher	6 EA	
5.	123.4102.20	#10 Medium Pattern Split Lockwasher	3 EA	
6.	123.6060.20	#6 Internal Tooth Steel Lockwasher	2 EA	
7.	123.6080.20	#8 Internal Tooth Steel Lockwasher	2 EA	
8.	151.0407.1659	M4 X .7 X 16 mm Phl.Pan.Metr.Screw	6 EA	
9.	151.0508.1659	M5X.8 X 16 mm Phc Metric Mach Screw	3 EA	
10.	4118.822.01	Kowa 1:0.75/50 Lens Locking Nut	1 EA	
11.	4147.824.01	6" TV Access Cover	1 EA	
12.	4402.824.06	6" TV Optics Support Column	1 EA	
13.	4424.822.03	Kowa 1:0.75/50 Lens Mnt Thomsn Tube	1 EA	
14.	4446.822.03	Eureka/Thomson Image Tube Mtg Plate	1 EA	
15.	6282.226.	F 0.75 50 mm CL62B13 Kowa Lens	1 EA	

TABLE 2-2 Parts List for 5536.822.05
6" Eureka/Thomson Optics Sprt Asm

CHAPTER 15

X-RAY TUBES

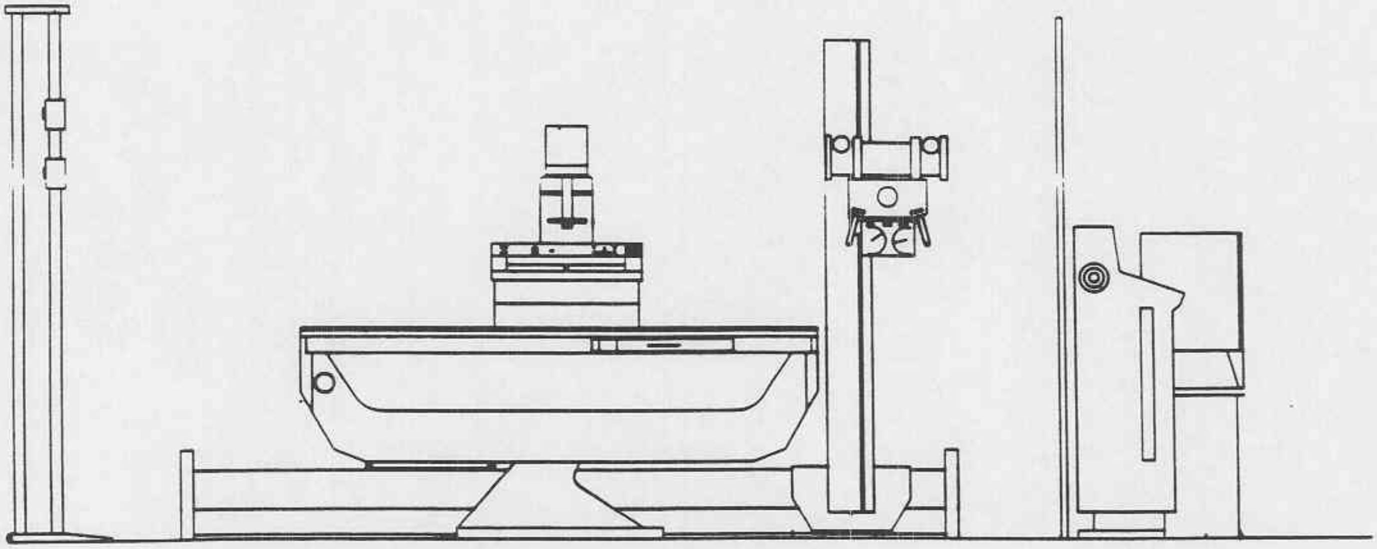


TABLE OF CONTENTS

CHAPTER 15 - X-RAY TUBES

SECTION NUMBER — DESCRIPTION — PAGE NUMBER

SECTION 1 - RAD-13 OVERTABLE ROTATING ANODE X-RAY TUBE 1-1

1.1 PRODUCT DATA 1-1
1.2 60 HZ RADIOGRAPHIC EXPOSURE CHARTS 1-2
1.3 60 HZ FILAMENT EMISSION CHARTS 1-3
1.4 50 HZ RADIOGRAPHIC EXPOSURE CHARTS 1-4

SECTION 2 - RAD-14 UNDERTABLE ROTATING ANODE X-RAY TUBE 2-1

2.1 PRODUCT DATA 2-1
2.2 60 HZ RADIOGRAPHIC EXPOSURE CHARTS 2-2
2.3 60 HZ FILAMENT EMISSION CHARTS 2-3
2.4 50 HZ RADIOGRAPHIC EXPOSURE CHARTS 2-4

LIST OF FIGURES

FIGURE NUMBER — DESCRIPTION — PAGE NUMBER

1-1 SINGLE PHASE, FULL WAVE, 60 HZ, 1.0 mm FOCAL SPOT RADIOGRAPHIC EXPOSURE CHART 1-2
1-2 SINGLE PHASE, FULL WAVE, 60 HZ, 2.0 mm FOCAL SPOT RADIOGRAPHIC EXPOSURE CHART 1-2
1-3 SINGLE PHASE, FULL WAVE, 60 HZ, 1.0 mm FOCAL SPOT FILAMENT EMISSION CHART 1-3
1-4 SINGLE PHASE, FULL WAVE, 60 HZ, 2.0 mm FOCAL SPOT FILAMENT EMISSION CHART 1-3
1-5 SINGLE PHASE, FULL WAVE, 50 HZ, 1.0 mm FOCAL SPOT RADIOGRAPHIC EXPOSURE CHART 1-4
1-6 SINGLE PHASE, FULL WAVE, 50 HZ, 2.0 mm FOCAL SPOT RADIOGRAPHIC EXPOSURE CHART 1-4

LIST OF FIGURES (continued)

FIGURE NUMBER	DESCRIPTION	PAGE NUMBER
2-1	SINGLE PHASE, FULL WAVE, 60 HZ, 0.6 mm FOCAL SPOT RADIOGRAPHIC EXPOSURE CHART	2-2
2-2	SINGLE PHASE, FULL WAVE, 60 HZ, 1.2 mm FOCAL SPOT RADIOGRAPHIC EXPOSURE CHART	2-2
2-3	SINGLE PHASE, FULL WAVE, 60 HZ, 0.6 mm FOCAL SPOT FILAMENT EMISSION CHART	2-3
2-4	SINGLE PHASE, FULL WAVE, 60 HZ, 1.2 mm FOCAL SPOT FILAMENT EMISSION CHART	2-3
2-5	SINGLE PHASE, FULL WAVE, 50 HZ, 0.6 mm FOCAL SPOT RADIOGRAPHIC EXPOSURE CHART	2-4
2-6	SINGLE PHASE, FULL WAVE, 50 HZ, 1.2 mm FOCAL SPOT RADIOGRAPHIC EXPOSURE CHART	2-4

SECTION 1 - RAD-13 OVERTABLE ROTATING ANODE X-RAY TUBE

1.1 PRODUCT DATA

Introduction

The RAD-13 Rotating Anode X-Ray Tube is rated to 150 kVp and features a 3″ 16° tungsten rhenium molybdenum target having a heat storage capacity of 300,000 heat units.

The 1.0 mm – 2.0 mm focal spot combination is standard. The RAD-13 insert is a heavy duty tube for general radiography.

The RAD-13 inserts are intended for use in, (but not limited to) the Eureka Diamond®/Emerald® series housings.

Physical Characteristics:

Frame:	Borosilicate glass with controlled window thickness
Inherent Filtration:	0.5 mm aluminum equivalent, minimum, at 100 kVp.
Weight:	Insert only: 3.7 lbs (1.68 kg) approx.
Focal Spot Combinations:	1.0 mm – 2.0 mm
Effective Target Angle:	16°
Target Diameter:	3.1 inches (80 mm)
Nominal Focal Track Diameter:	2.5 inches (63 mm)
Target Material:	Tungsten-rhenium track on a molybdenum alloy substrate
X-ray Field Coverage:	41 in^2 (104 cm^2) FLD at 72 in. (180 cm) SRD 23 in^2 (58 cm^2) FLD at 40 in. (100 cm) SRD

Thermal Characteristics:

Anode Heat Storage Capacity:	300,000 H.U. (222,000 J.)
Anode Heat Dissipation Rate:	60,000 H.U./Min Max. (740 Ws)

Electrical Characteristics:

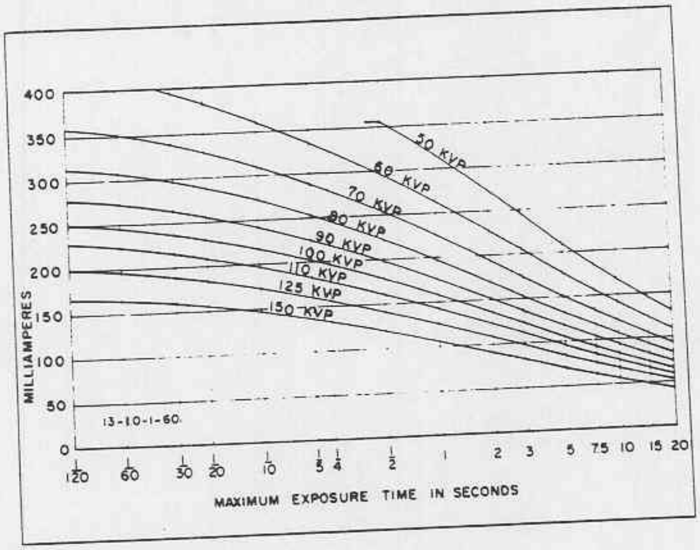
Maximum Peak Voltages:	Anode to cathode 150 kVp Anode to ground 82 kVp Cathode to ground 82 kVp

Filament Characteristics:

Focal Spot	Voltage (V)	Current (A)
1.0 mm	5.3 – 10.3	4.0 – 5.5
2.0 mm	7.6 – 12.4	4.0 – 5.5

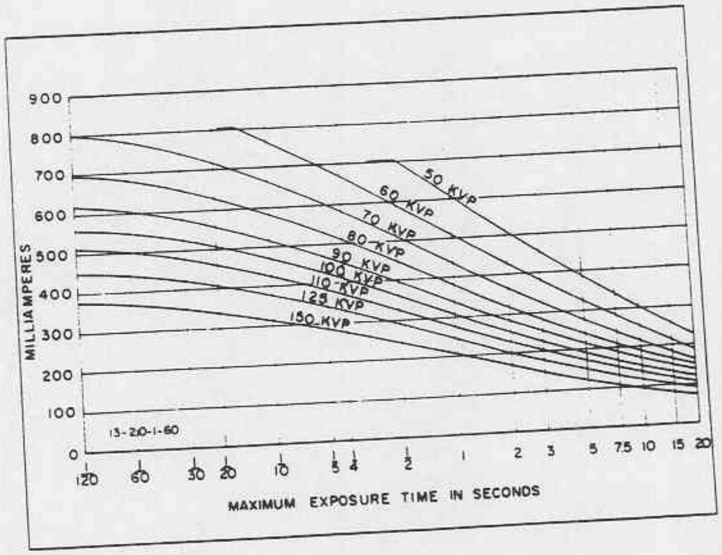
Maximum Continuous Filament Current:	3.3 Amperes or to a value which will produce a tube current of 3 mA or less at 80 kVp.
Maximum Energy:	Refer to rating charts

1.2 60 HZ RADIOGRAPHIC EXPOSURE CHARTS



SINGLE PHASE, FULL WAVE, 60 HZ, 1.0 mm FOCAL SPOT
RADIOGRAPHIC EXPOSURE CHART

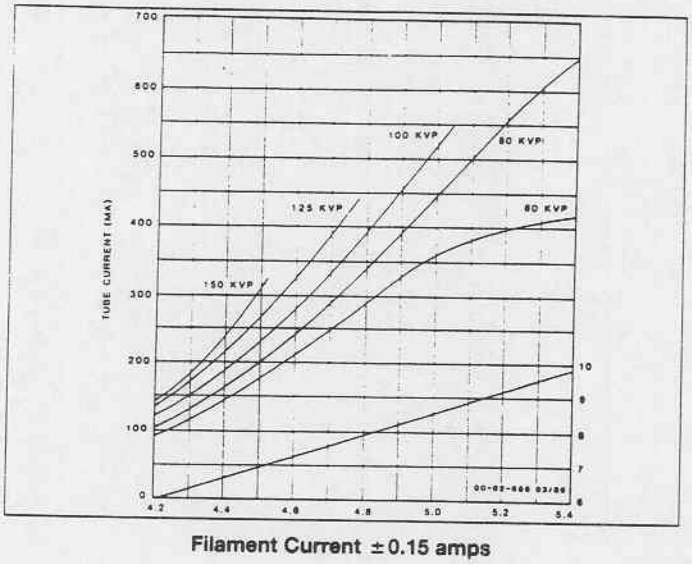
FIGURE 1-1



SINGLE PHASE, FULL WAVE, 60 HZ, 2.0 mm FOCAL SPOT
RADIOGRAPHIC EXPOSURE CHART

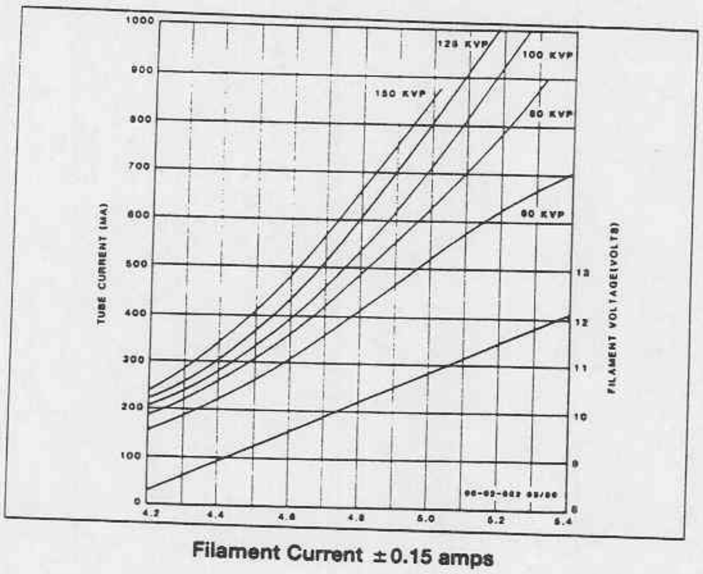
FIGURE 1-2

1.3 60 HZ FILAMENT EMISSION CHARTS



SINGLE PHASE, FULL WAVE, 60 HZ, 1.0 mm FOCAL SPOT
FILAMENT EMISSION CHART

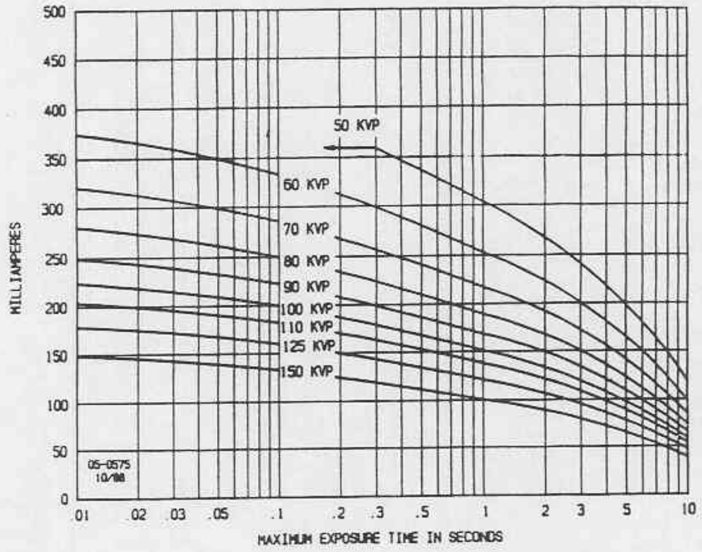
FIGURE 1-3



SINGLE PHASE, FULL WAVE, 60 HZ, 2.0 mm FOCAL SPOT
FILAMENT EMISSION CHART

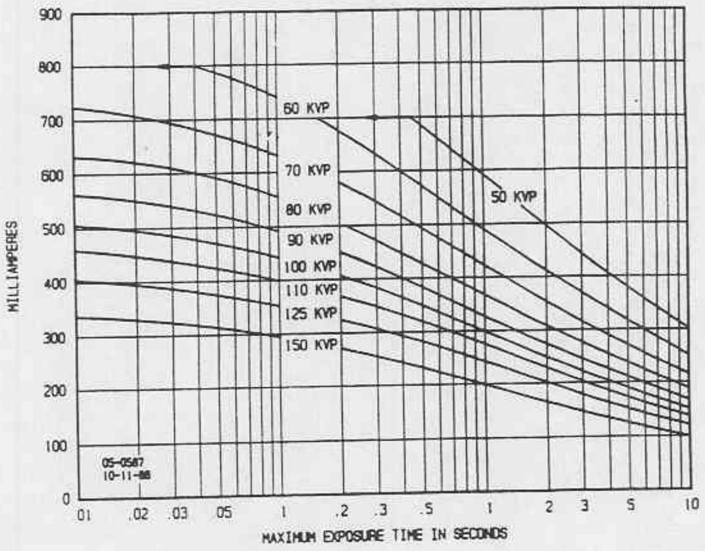
FIGURE 1-4

1.4 50 HZ RADIOGRAPHIC EXPOSURE CHARTS



SINGLE PHASE, FULL WAVE, 50 HZ, 1.0 mm FOCAL SPOT
RADIOGRAPHIC EXPOSURE CHART

FIGURE 1-5



SINGLE PHASE, FULL WAVE, 50 HZ, 2.0 mm FOCAL SPOT
RADIOGRAPHIC EXPOSURE CHART

FIGURE 1-6

SECTION 2 - RAD-14 UNDERTABLE ROTATING ANODE X-RAY TUBE

2.1 PRODUCT DATA

Introduction

The RAD-14 Rotating Anode X-Ray Tube is rated to 150 kVp and features a 3″ 12° tungsten rhenium molybdenum target having a heat storage capacity of 300,000 heat units.

The RAD-14 inserts are heavy duty tubes for general radiographic and fluoro/spot film procedures. Superimposed focal spot combinations of 0.3 mm – 1.2 mm and 0.6 mm – 1.2 mm are available.

The RAD-14 inserts are intended for use in, (but not limited to) the Eureka Diamond®/Emerald® series housings.

Physical Characteristics:

Frame:	Borosilicate glass with controlled window thickness
Inherent Filtration:	0.5 mm aluminum equivalent, minimum, at 100 kVp.
Weight:	Insert only: 3.7 lbs (1.68 kg) approx.
Focal Spot Combinations:	0.3 mm – 1.2 mm 0.6 mm – 1.2 mm
Effective Target Angle:	12°
Target Diameter:	3.1 inches (80 mm)
Nominal Focal Track Diameter:	2.5 inches (63 mm)
Target Material:	Tungsten-rhenium track on a molybdenum alloy substrate
X-ray Field Coverage:	17 in^2 (43 cm^2) FLD at 40 in. (100 cm) SRD

Thermal Characteristics:

Anode Heat Storage Capacity:	300,000 H.U. (222,000 J.)
Anode Heat Dissipation Rate:	60,000 H.U./Min Max. (740 W)

Electrical Characteristics:

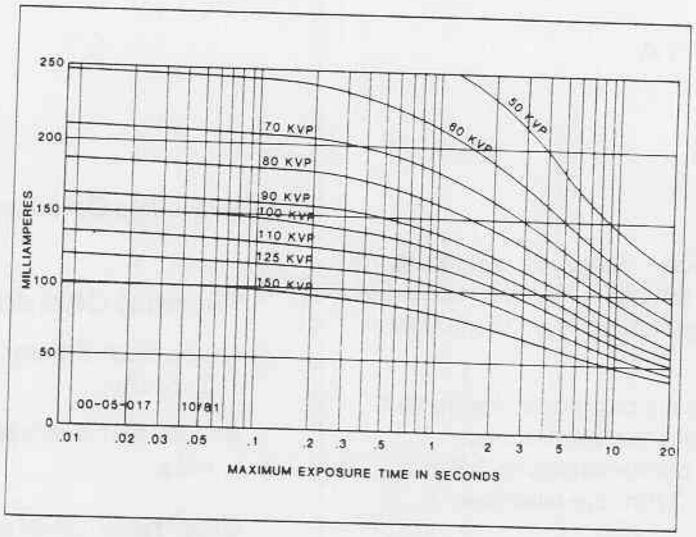
Maximum Peak Voltages:	Anode to cathode 150 kVp Anode to ground 82 kVp Cathode to ground 82 kVp

Filament Characteristics:

Focal Spot	Voltage (V)	Current (A)
0.3 mm	5.35 – 7.7	3.0 – 4.5
0.6 mm	4.15 – 6.6	4.0 – 5.2
1.2 mm	7.8 – 12.8	4.3 – 5.5

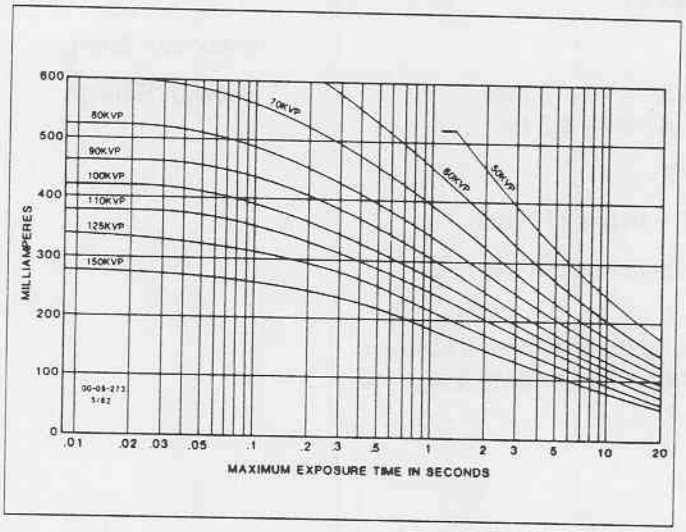
Maximum Continuous Filament Current:	3.3 Amperes or to a value which will produce a tube current of 3 mA or less at 80 kVp.
Maximum Energy:	Refer to rating charts
Kilowatt Ratings:	

2.2 60 HZ RADIOGRAPHIC EXPOSURE CHARTS



SINGLE PHASE, FULL WAVE, 60 HZ, 0.6 mm FOCAL SPOT
RADIOGRAPHIC EXPOSURE CHART

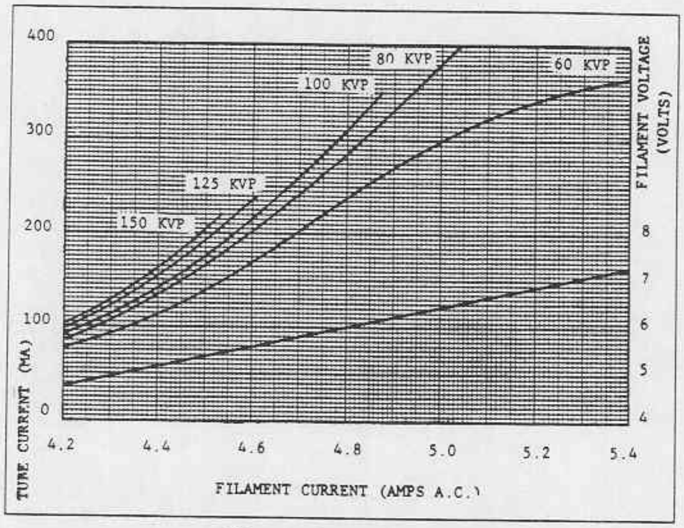
FIGURE 2-1



SINGLE PHASE, FULL WAVE, 60 HZ, 1.2 mm FOCAL SPOT
RADIOGRAPHIC EXPOSURE CHART

FIGURE 2-2

2.3 60 HZ FILAMENT EMISSION CHARTS

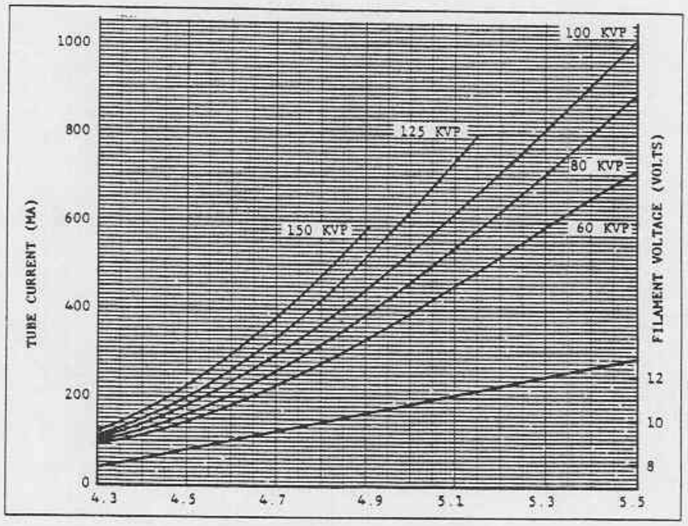


Filament Current ±0.15

SINGLE PHASE, FULL WAVE, 60 HZ, 0.6 mm FOCAL SPOT
FILAMENT EMISSION CHART

FIGURE 2-3

1.2 mm Focal Spot

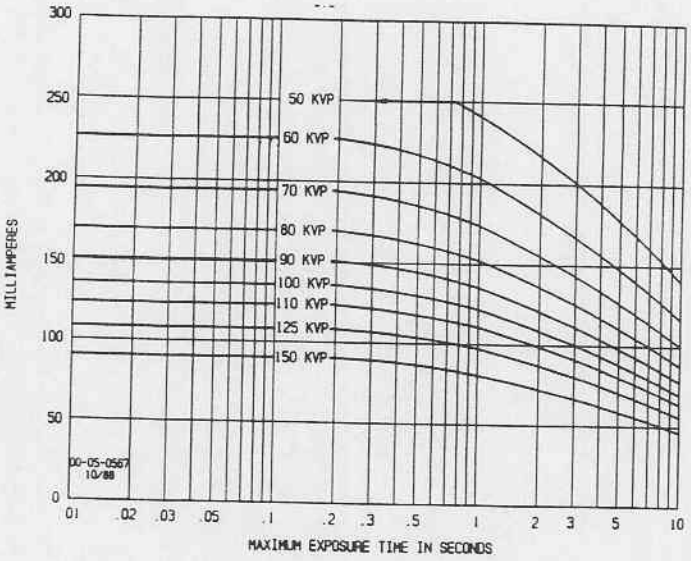


Filament Current ±0.15

SINGLE PHASE, FULL WAVE, 60 HZ, 1.2 mm FOCAL SPOT
FILAMENT EMISSION CHART

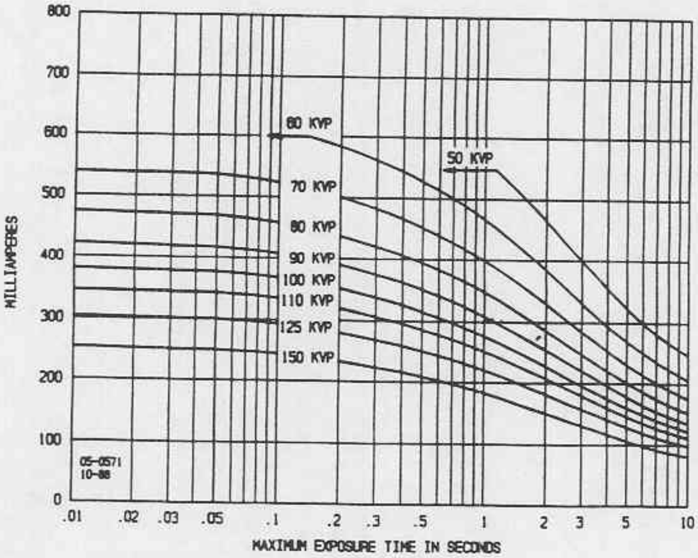
FIGURE 2-4

2.4 50 HZ RADIOGRAPHIC EXPOSURE CHARTS



SINGLE PHASE, FULL WAVE, 50 HZ, 0.6 mm FOCAL SPOT
RADIOGRAPHIC EXPOSURE CHART

FIGURE 2-5



SINGLE PHASE, FULL WAVE, 50 HZ, 1.2 mm FOCAL SPOT
RADIOGRAPHIC EXPOSURE CHART

FIGURE 2-6

CHAPTER 16

MISCELLANEOUS

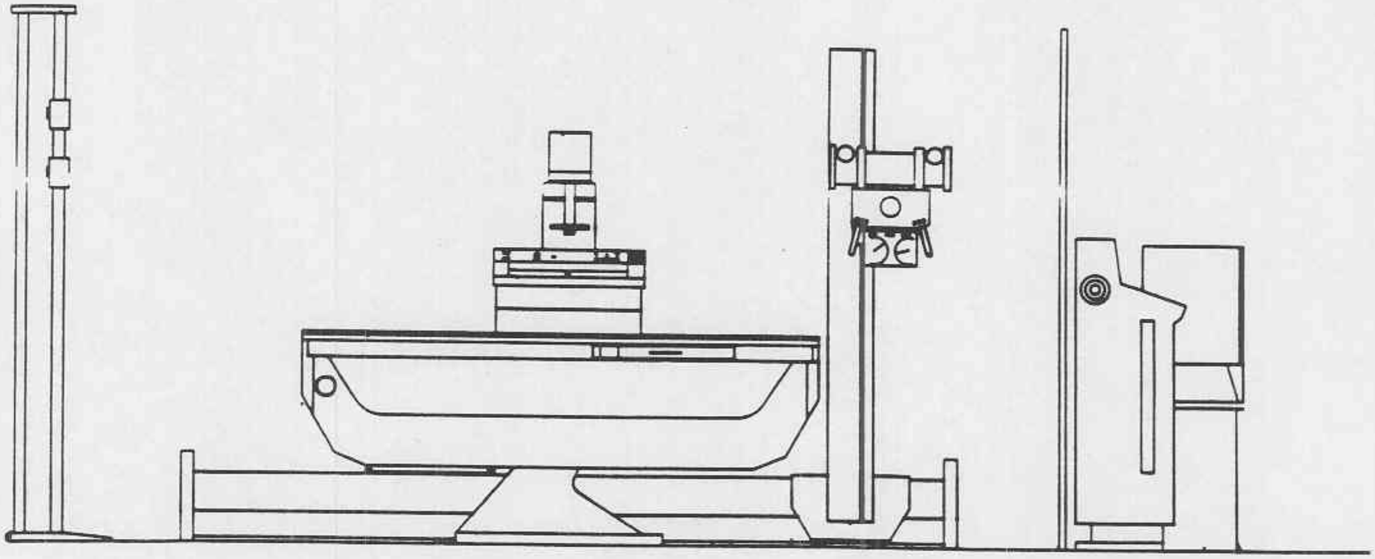


TABLE OF CONTENTS

CHAPTER 16 - MISCELLANEOUS

SECTION NUMBER	DESCRIPTION	PAGE NUMBER
SECTION 1 - MOBILE CASSETTE HOLDER		Page 1-1
SECTION 2 - LATERAL CASSETTE/GRID HOLDER		Page 2-1
SECTION 3 - MCT SIZE SENSING TRAY		Page 3-1
SECTION 4 - RADIATION SHIELD		Page 4-1

LIST OF FIGURES

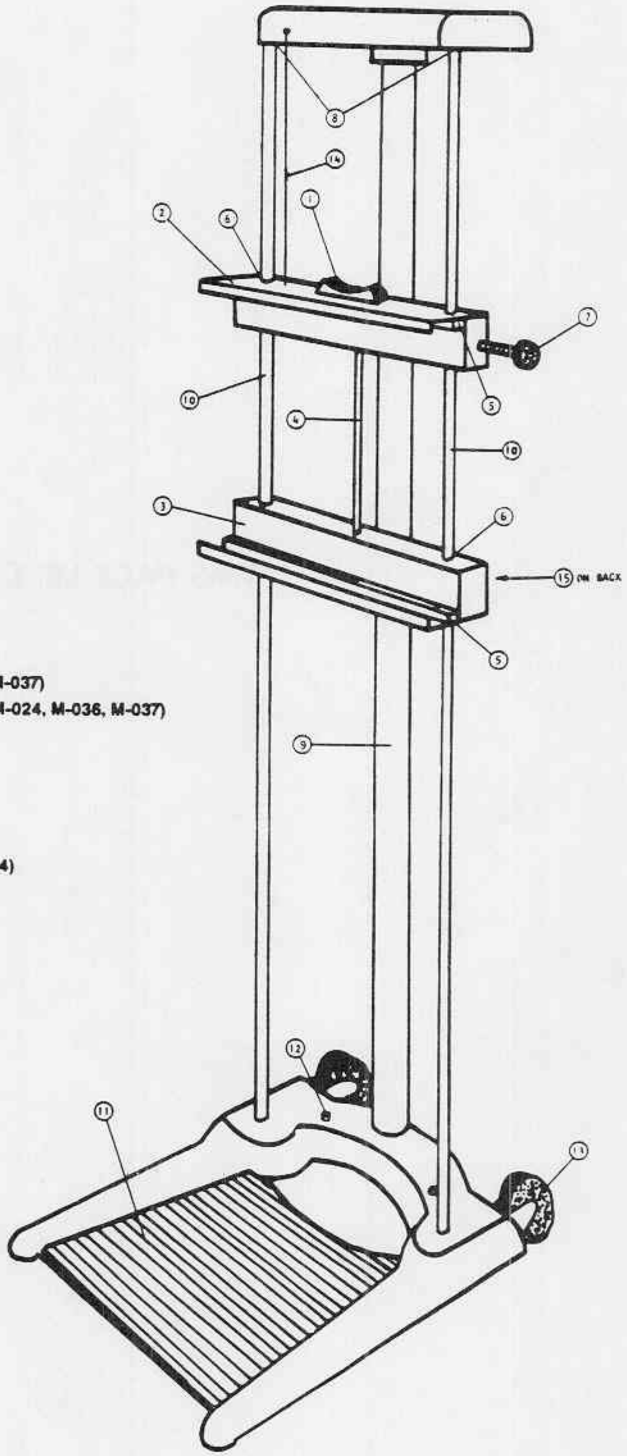
FIGURE NUMBER	DESCRIPTION	PAGE NUMBER
1-1	LAYOUT AND PARTS LIST FOR MOBILE CASSETTE HOLDER	Page 1-1
2-1	LAYOUT FOR LATERAL CASSETTE/GRID HOLDER	Page 2-1
3-1	LAYOUT FOR MCT SIZE SENSING TRAY	Page 3-1
4-1	LAYOUT FOR RADIATION SHIELD	Page 4-1

LIST OF TABLES

TABLE NUMBER	DESCRIPTION	PAGE NUMBER
2-1	PARTS LIST FOR LATERAL CASSETTE/GRID HOLDER	Page 2-2
3-1	PARTS LIST FOR MCT SIZE SENSING TRAY	Page 3-2
4-1	PARTS LIST FOR RADIATION SHIELD	Page 4-2

CHAPTER 16 - MISCELLANEOUS

SECTION 1 - MOBILE CASSETTE HOLDER



1. CHIN REST (M-021)
2. UPPER CASSETTE SLIDE (M-017, M-020, M-036, M-037)
3. LOWER CASSETTE SLIDE (M-017, M-019, M-020, M-024, M-036, M-037)
4. CONNECTOR ROD (M-035)
5. GAUGE BAR (M-056)
6. THIN NYLINER 5/8" (8) (M-012)
7. VERTICAL LOCK KNOB (M-022, M-022-2)
8. RUBBER WASHER (2) (M-004)
9. SUPPORT ASSEMBLY (M475-01) M475-03, M475-04)
10. SLIDE ROD (M475-05)
11. RUBBER MAT (M475-07)
12. LEVELING SCREWS (M475-07)
13. WHEEL WITH BRACKET (2) (M-028-1)
14. COUNTER BALANCE 6# (2) (M-008)
15. STAR KNOB (M-013)

FIGURE 1-1 LAYOUT AND PARTS LIST FOR MOBILE CASSETTE HOLDER

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SECTION 2 - LATERAL CASSETTE/GRID HOLDER

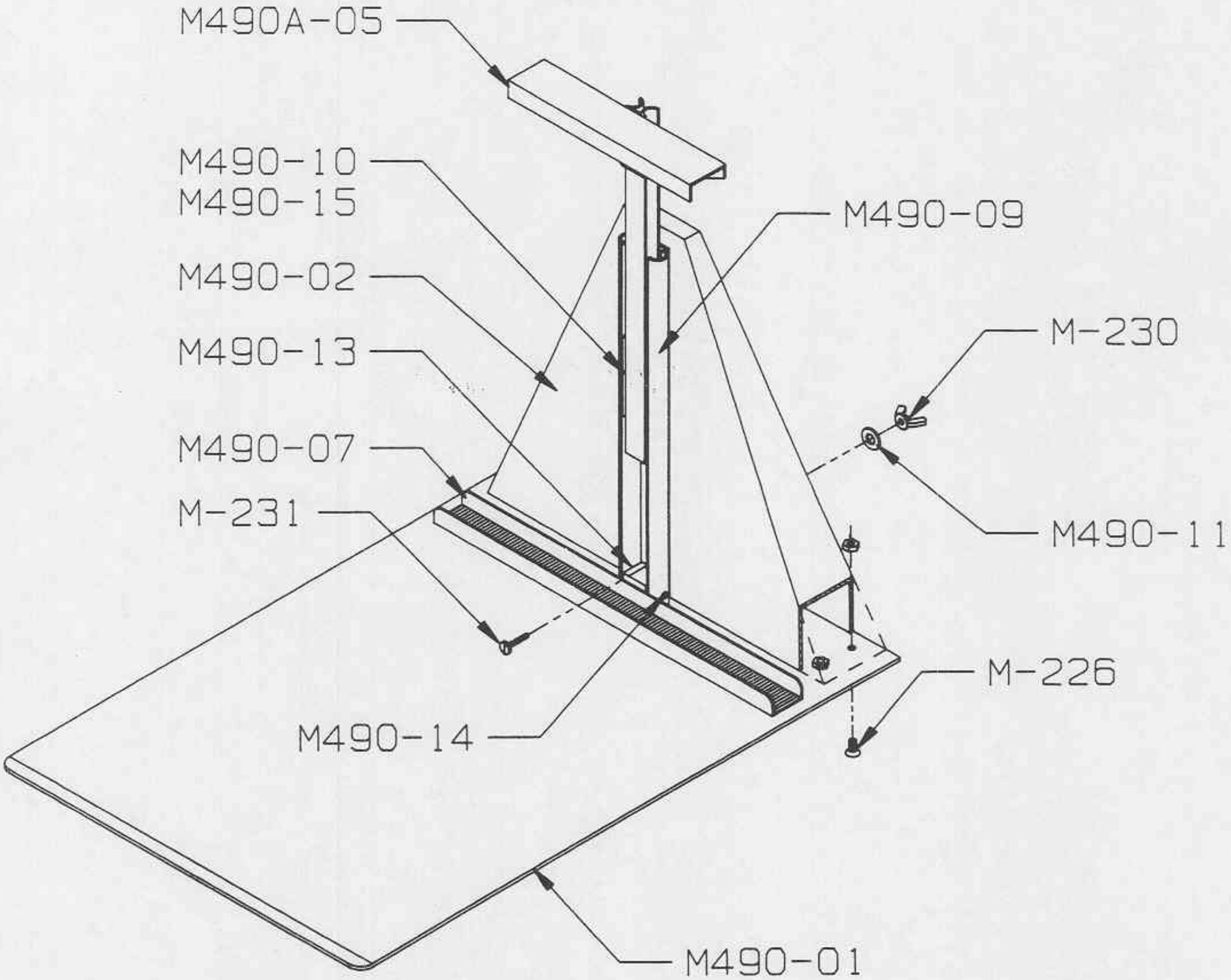

M490A-05
M490-10
M490-15
M490-09
M490-02
M-230
M490-13
M490-07
M490-11
M-231
M-226
M490-14
M490-01

FIGURE 2-1 LAYOUT FOR LATERAL CASSETTE/GRID HOLDER

M-231	10-32X1/2 SPHMS-ZINC
M490A-05	CASS CNL UPPER WIDE ASM
M490-15	5/16 BALL BEARING
M490-14	STOP PIN-OUTER CHNL
M490-13	CENTER RUBBER STOP
M490-10	BALL BEARING RETAIN
M490-09	SLIDE OUTTER CNL
M490-07	CASS CHNL-LOWER-WIDE
M490-02	TRIANGLE WELD-GRIND PAINT
M490-01	BASE PLATE
M-230	10-32 WING NUT-PLTD
M-226	8-32X3/8 SFHMS-UC-PD

TABLE 2-1 PARTS LIST FOR LATERAL CASSETTE/GRID HOLDER

SECTION 3 - MCT SIZE SENSING TRAY

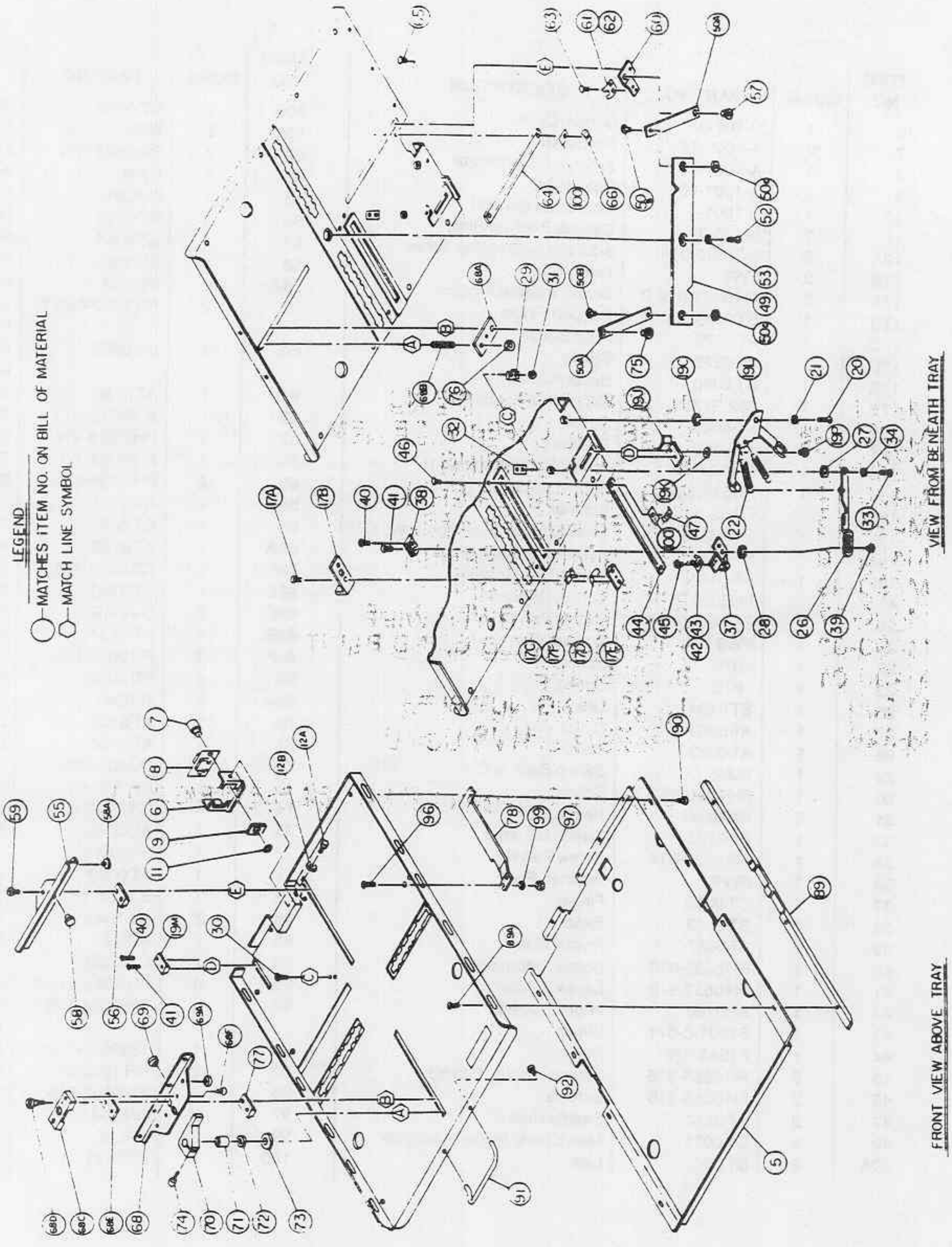
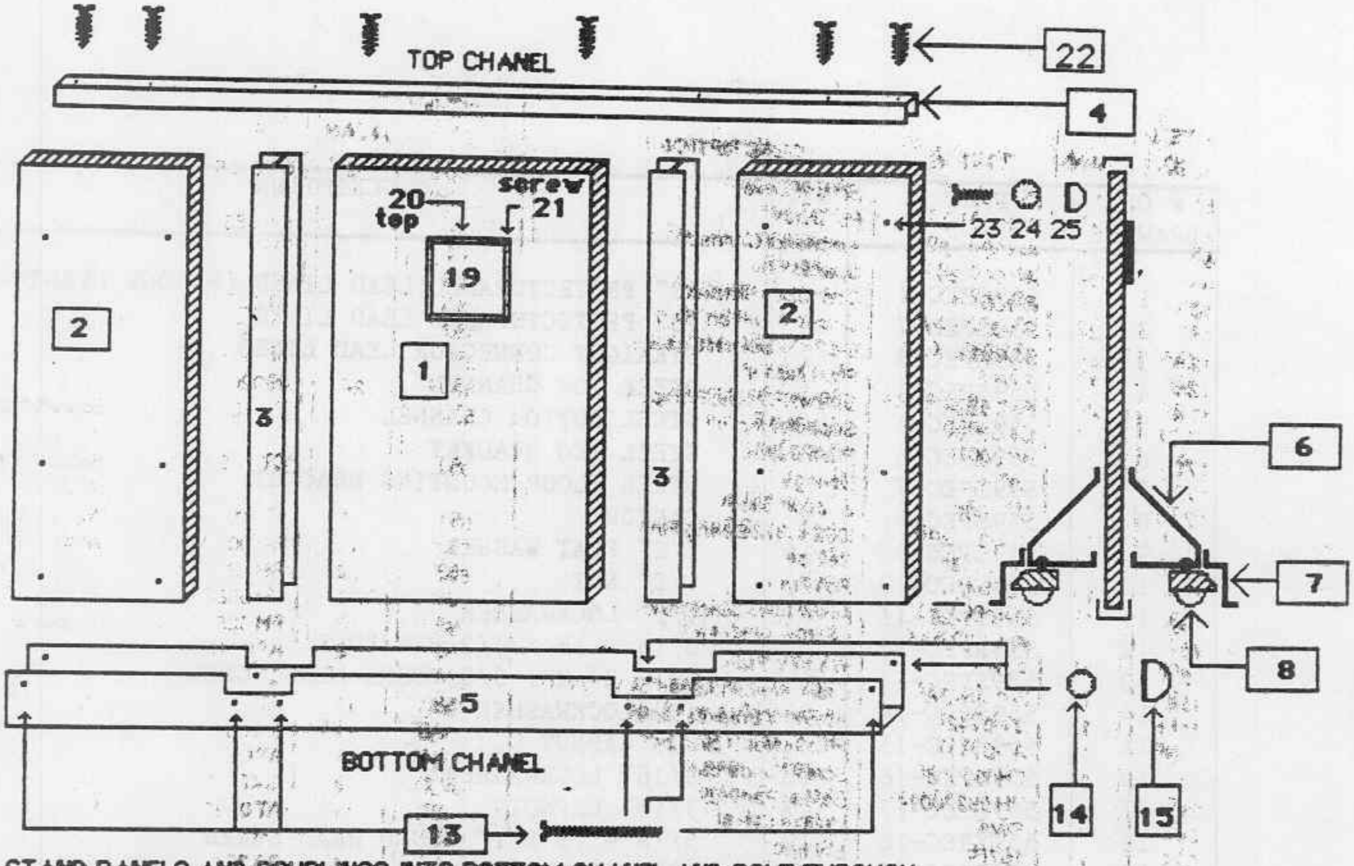

LEGEND
○ — MATCHES ITEM NO. ON BILL OF MATERIAL
⬡ — MATCH LINE SYMBOL
VIEW FROM BENEATH TRAY
FRONT VIEW ABOVE TRAY
A
B
C
D
E
5
6
7
8
9
11
12A
12B
17A
17B
17C
17D
17E
20
21
22
26
27
28
29
30
31
32
33
34
37
38
39
40
41
42
43
44
45
46
47
49
50A
50B
52
53
55
56
57
58
58A
59
61
62
63
64
66
68
68A
68B
68C
68D
68E
68F
69
69A
70
71
72
73
74
75
76
77
78
89
89A
90
91
92
96
97
99
100

FIGURE 3-1 LAYOUT FOR MCT SIZE SENSING TRAY

ITEM NO.	QUAN.	PART NO.	DESCRIPTION
5	1	D-1001-3	Bottom Cover
7	2	A-1001-18	Pin Guide
8	1	A-1001-19	Amphenol Connector
9	2	A-1001-20	Spacer Bar
10	1	B-1001-1	Connector Bracket
11	2	S-105-31-H	Circular Push on Ring
12A	2	SC0832-014	8-32 X ¼ Socket Cap Screw
12B	2	FW8	Flat Washer
17A	2	FH 0632-014-P	Screw, Plastite, Phillips
17B	1	BT 0059	Support Finger
17C	1	AT 0076	Push Button
17D	1	AT 0079	Spring
17E	1	BT 0080	Support Slide
17F	1	062-3125P	.062 x .312 Spring Pin
19E	1	AT-0066	Striker
19F	1	125-150	Roll Pin
19J	1	B-1001-20	Activator Bracket (rev. 1)
40	1	FH632-038	Screw, Undercut
19K	1	FW14	Washer, Flat
19L	1	B-1001-5A	Crank welded Assembly (rev. 1)
19M	1	BT-0142	Activator Bracket Slide
19P	1	AT-0141	Pivotal Nut, Activator
41	1	FH632516	Screw, Undercut
20	1	PH 08320014	Screw, Pan Hd.
21	1	FW8	Washer, Flat
22	1	167B	Spring
23	1	167B	Spring
26	1	BT 0104	Link
27	1	AT 0063-2	Collar
28	1	AT 0063-1	Collar
29	1	2LML-C	Switch Spdt. N.C.
30	1	FH 0256-038	Screw
31	2	HN 0256	Hex Nut
32	1	AT 0132	Switch Insulator
33	1	PH 0832-014	Screw Pan Hd.
34	1	FW 8	Washer, Flat
37	1	CT 0082	Finger
38	1	BT 0083	Slider
39	1	AT 0057	Pivotal Nut
40	1	FH 0632-038	Screw, Undercut
41	1	FH 0632-516	Screw, Undercut
42	1	AT 0130	Wiper Insulator
43	1	S1001-0-071	Wiper
44	1	F1088-7 (P)	Pot
45	2	PH 0256-316	Screws, Nylon, Pan Hd.
46	2	FH 0256-316	Screws
47	2	AT 0112	Saddle Nuts
49	1	CT 0071	Main Crank Welded Assembly
50A	2	BT 0062	Link
50B	2	BT 0109	Shoulder Rivet
50C	2	FW6	Flat Washer
52	1	PH 0832-014	Screw, Pan Hd.
53	1	FW8	Washer, Flat
55	1	C 1001-2	Rear Clamp
56	1	AT 0093	Slide
57	1	AT 0048	Pivotal Nut
58	4	BB 3065	Rubber Pads
58A	2	090201	Nylon Pads
59	2	PH 1032-038-T	Screw, Pan Hd., Taptite, Phillips
60	1	CT 0085	Rear Clamp Wiper Mtg. Bkt.
61	1	AT 0130	Wiper Insulator
62	1	S-10010-071	Wiper
63	2	PH 0256-316	Screw, Nylon, Pan Hd.
64	1	F-10088-7 (P)	Pot
65	2	FH 0256-316	Screws
66	2	AT 0112	Saddle Nuts
68	1	CT 0092	Front Clamp
68A	1	AT 0139	Mounting Plate
68B	1	SS 051618-1	Socket Set Screw
68C	1	AT 0140	Front Clamp Bar
68D	2	G 42-19	Shoulder Screw
68E	1	AT 0137	Front Clamp Pad
68F	2	FH 0632-038	Screw
69	4	BB 3065	Rubber Pads
69A	2	120241	Nylon Pads
70	1	AT 0136	Lock Handle
71	1	AT 0138	Lock Handle Bushing
72	1	BO 625-032-5	Spring Washer
73	1	FW 516-03	Brass Washer
74	1	CS 0832-058	Handle Screw
75	1	AT 0048	Pivotal Nut
76	1	HN 0516	Hex Nut
77	1	AT 0093	Slider
78	1	B 1001-18	Tray Latch
84	2"	12-1042	Heat Shrink Tubing
85	2	ACC2	Cable Holder
89	2	CT 0062	Tray Slide
89A	8	FH 0632-014-P	Screw, Plastite, Phillips
90	4	PH 0632-316-T	Screw, Pan Hd., Taptite, Phillips
91	1	13326-B-1032	Handle, 4" x 2½ Dp.
92	2	RH 1032-012	Screw, RH
96	2	FH 0632-014	Screw
97	2	HN 0632	Hex Nut
99	2	SRL-6	Split Ring Lock Washer
100	2	AT 0131	Pot Insulator

TABLE 3-1 PARTS LIST FOR MCT SIZE SENSING TRAY

SECTION 4 - RADIATION SHIELD


22
TOP CHANEL
4
20 top
screw 21
19
2
1
3
3
2
23 24 25
6
7
8
5
BOTTOM CHANEL
13
14
15

1 STAND PANELS AND COUPLINGS INTO BOTTOM CHANEL AND BOLT THROUGH TABS IN CHANEL.
2 SCREW TOP CHANEL TO TOPS OF PANELS USING SHEET METAL SCREWS
3 ASSEMBLE LEGS AND CASTERS AND BOLT THROUGH HOLES IN PANELS
4 SCREW FLOOR MOUNTING BRACKET TO FLOOR IF PERMANENT MOUNTING IS DESIRED

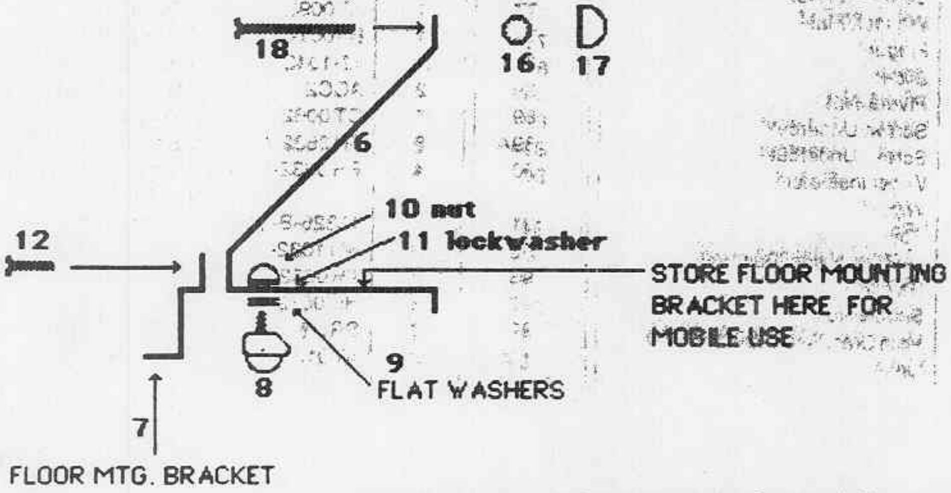

18
16
17
6
10 nut
11 lockwasher
12
STORE FLOOR MOUNTING BRACKET HERE FOR MOBILE USE
8
9
FLAT WASHERS
7
FLOOR MTG. BRACKET

FIGURE 4-1 LAYOUT FOR RADIATION SHIELD

# ON DRAWING	PART #	QTY	DESCRIPTION
1	559SPEC-1	1	30" PROTECTOPANEL LEAD LINED (WINDOW OPENING)
2	559SPEC-2	2	18" PROTECTOPANEL LEAD LINED
3	559SPEC-3	2	STRAIGHT CONNECTOR LEAD LINED
4	559SPEC-4	1	STEEL TOP CHANNEL
5	559SPEC-5	1	STEEL BOTTOM CHANNEL
6	559SPEC-6	8	STEEL LEG BRACKET
7	559SPEC-7	8	STEEL FLOOR MOUNTING BRACKET
8	559SPEC-8	8	CASTOR
9	559SPEC-9	16	1/2" FLAT WASHER
10	559SPEC-10	8	1/2" NUT
11	559SPEC-11	8	1/2" LOCKWASHER
12	559SPEC-12	8	5/16 - 18 X 1/2 HEX BOLT
13	559SPEC-13	6	10 - 24 X 1 3/8 ROUND HEAD SCREW
14	559SPEC-14	6	#10 LOCKWASHER
15	559SPEC-15	6	#10 CAPNUT
16	559SPEC-16	12	5/16" LOCKWASHER
17	559SPEC-17	12	5/16" CAPNUT
18	559SPEC-18	12	5/16 - 18 X 1" ROUND HEAD SCREW
19	559SPEC-19	1	10"X 12" LEAD GLASS WINDOW
20	559SPEC-20	1	WINDOW RETAINER CHANNEL
21	559SPEC-21	2	#4 X 1/8 ROUND HEAD SCREW
22	559SPEC-22	6	#8 X 1/2 SHELF TOPPING SCREW
23	559SPEC-23	12	1/4 - 20 X 1/2" ROUND HEAD SCREWS
24	559SPEC-24	12	1/4" LOCKWASHER
25	559SPEC-25	12	1/4" CAPNUT

TABLE 4-1 PARTS LIST FOR RADIATION SHIELD